THE

ELECTRICAL REVIEW.

VOL. XXXIII. DECEMBER 1, 1893. No. 836

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SOME POINTS IN ELECTRIC TRACTION.

THE electric railway and tramway is slowly coming into use in this country. Here we have only a few examples compared with the many in America; but these few examples are, however, quite sufficient to show up all the points of interest; to present problems yet to be solved in electric traction; and to demonstrate the advantages of the electric motor over the horse and steam power.

An interesting question is whether series or shunt motors are preferable for this class of work. In America where the trolley system is almost universal, with the rails as the return, the series motor is invariably adopted. One reason for this preference often stated, is based, however, on a fallacy, namely, that the series motor exerts more torque at starting than does a shunt motor. Now, this all depends on many things, principally on the dimensions of the field magnets; for given a motor, first wound and worked in series, and then the series field winding replaced by a suitable and properly calculated shunt winding, it will be found that with the fields fully excited, that is, at full saturation with equal armature currents, the torques are equal, but if we want a more powerful starting torque in the series motor, we require to pass the whole current through the field coils, although in doing so we do not increase the field strength; but the increased torque due to the large increase of current is due to the current increasing in the armature coils only. Up to the saturation point the increase of torque with increase of current in a series motor is due to both increased field strength and current in armature, but beyond the saturation of the magnets the increase is due to current only. Hence, the $C^2 R$ losses in the field of a series motor is greatest at greatest torques, and the magnetic flux is not proportional.

In the shunt motor the field is worked up to saturation constantly, so that the $C^2 R$ loss in the field is constant and the torque is proportional to the current in the armature coils. However great or little it may be, the whole work of the current is performed in the armature to produce torque at starting. And, further, while the series motor is not self-regulating, but may race on a declivity or on a level, the shunt motor has a speed beyond which, if it is carried by the car, on a declivity it acts as a brake and feeds current into the line, assisting the generators and tending to prevent racing automatically. The shunt motor is theoretically preferable, but it has a serious drawback in practice, when worked by a trolley and rail returns. In this method of working, the contact between the wheels and rails is sometimes bad, so that the current is cut off momentarily, and the magnets of the shunt motor losing their exciting power, the armature takes an enormously large current when contact is again made good. These large influxes of current cause serious troubles, and principally on that account series motors are preferred for the trolley system.

The series motor may be worked on another plan, whereby,

after the current reaches a value to fully saturate the fields, any additional current required to start the train is shunted past the field coils directly into the armature, this shunted current being first cut off when a start has been made; but, whether series or shunt motors are used, the great loss of energy in starting is a serious loss for which no satisfactory remedy has as yet been proposed. An electric motor is in this respect exactly like a horse or a turbine, if a horse is hitched up to a load which it can start only with great difficulty, or which it cannot start at all, it exerts its greatest energy and may continue to do so for a considerable time, and yet do no work at all in moving the load, the whole of its energy being lost in its own muscles, during the time of exertion, but no external work is done. Similarly, a turbine wheel may be held by an overload or be fixed purposely, the full current of water may then flow through it and yet no work can be done by the turbine; a man may hold a weight out at arm's length steadily for some time, exerting all the energy of his muscles, yet he does no work during that time, the energy he expends is lost internally. So it is with the electromotor: prevent it from moving and it consumes energy in itself when current is turned into it, and yet so long as it does not move, it does no work. If the motor moves slowly less energy is lost; when the motor goes at full speed only about 5 per cent. of energy may be lost, the work done is proportional to the speed, the less the speed the less the work done compared with the energy expended, so that at no speed no work is done and all the energy is lost. When the motor is starting a current of 100 ampères may be passed through the armature, with only perhaps 10 volts at its terminals, so that on a 200-volt circuit 190 volts are lost in dead resistances at the start.

Due to this starting of electromotors with full load on in tramways and railways, the efficiency is very much impaired, and some method of reducing the pressure without this great sacrifice of energy is at present a very important desideratum.

Presently the currents in traction motors are controlled by two methods, first by variable resistance which dissipates the energy when it is excessive, and, secondly, by coupling up two or more motors in series to reduce the current, or in parallel to increase the current. These are but crude methods at the best; the energy consumed in regulating resistances is lost and the coupling in parallel or series is a very limited method, the jump from series to parallel, or *vice versâ*, is too great, so that where it is employed resistances also must be used with it. On a survey of the whole subject, there are two directions in which we may hope to escape from these troubles, which, although not serious enough to be prohibitive to the working of electric traction, still demand attention; and these are in the use of transformers by which the electric pressures can be regulated without being dissipated, this may mean the use of low frequency alternating currents for electric traction, or storage batteries with multiple switch couplings, so that we can obtain a low pressure and a large current, or a full pressure and a large current without dissipation of the energy by resistances.

Battery traction can be best carried on by shunt motors; here the current is entirely in the control of the driver.

Given batteries, much can be done in raising the efficiency of electric traction. Instead of various couplings of several motor armatures, we can arrange various battery couplings to give the low pressures best suited for starting and high pressure for running uphill or on a level; this method has never been fully worked out. The difficulties with batteries themselves seem to have absorbed the whole energies of those engaged on battery cars.

The storage battery, if perfect enough for the work, might thus solve some of the problems. Suppose we had a shunt motor or, rather, a motor excited by a separate battery, and another battery capable of being joined up, all in series, or in series parallel combinations for feeding the armature, we might, for instance, couple on a large current of low pressure at the start and increase the pressure by altering the series connections as speed increased, and, with this plan, avoid all losses in regulating resistances, and, at the same time, expend a minimum of energy in starting from a state of rest, for, although the armature current would be large and the torque proportionately large, the E.M.F. would be small, it might be only 20 volts in some cases.

This means a complication of switching gear; and perhaps the game would not be worth the candles, but still it is a feasible plan with storage battery traction.

The same thing could be done with transformers and alternating motors; here we meet the question whether alternating motors are good enough for the purpose. So that we are met in both cases where a remedy for the starting troubles could be looked for by the question as to whether the vital apparatus proposed for the purpose are good enough, the storage battery in the one case and the alternating motor in the other. The electric way of efficient starting is to transform the pressures to meet the requirements instead of wasting the greater part of it in resistances.

The design of motors is of the utmost importance in traction work. Rightly or wrongly it is difficult to determine, the Americans have adopted the ironclad form of motor and a single reduction gear, and, by dint of good practical engineering have produced a gearing and motor which serve their purpose wonderfully; still, there is room for improvement and development of motors for railway and tramway work, and we may reasonably expect better designs in which every detail is settled on a more thoroughly scientific basis.

Elmore.

THE shareholders of Elmore's Patent Copper Depositing Company have been informed that an issue of £10,000 in debentures will probably be necessary at an early date, and that a reduction of capital will have to be faced before dividends can be declared, but it was not anticipated that for this purpose any haste in the reduction will be needed. The chairman's statement, which appears in another column, compared very favourably with those which have been made at previous meetings. One of the shareholders remarked that it bore the impress of truth, as if he considered such an impress unusual at an Elmore meeting. The loss last year was £13,000. The chairman was able to show that orders had increased, but gave no indication of the profit likely to be derived from them. Elmore tubes are still awaiting the test of practical work, and the evidence as to the coating of steamship shafts was limited to an expression of opinion. We gather that the present directors are doing their utmost to develop a genuine business, and they have our sympathy in their efforts. We hope that success will attend them. We must assume that they will not embark further capital unless they are

satisfied that a profitable return may be expected from it. We should suppose that the profitable use of present plant would be better than laying down additional plant to undertake doubtful work. So long, however, as the company confines itself to practical work we shall have no ground for criticisms, but we deem it expedient to warn investors against any purchase of shares on "hopes." Let them await actual results. The report of the official receiver and liquidator of the French Elmore Company has just been issued and is of considerable importance, but we are obliged to hold over its publication until next week.

Okonite.

THE Okonite Company has also held a meeting, and the only satisfaction the shareholders are afforded for their losses, is to indulge in recrimination against the American vendors. We presume no one concerned in the promotion of this company is free from blame, but we fear the chief responsibility rests much nearer home.

Wasted Capital.

THAT the Elmore and the Okonite Companies should have many features in common is not surprising, since they were promoted by the same firm. One of those features is the waste of money in running unproductive works which are needed to justify the original payments of purchase moneys, and to maintain for a sufficient period a position of apparent importance. Another feature is the readiness of the shareholders to reconstruct, or liquidate, or find more money, or do anything but take stringent measures to recover from vendors or promoters a portion of their wasted capital.

Traction Regulations.

THE rules suggested by the Board of Trade for the regulation of electric traction are as fair and as little obscure as one could have reasonably expected. They impose on the tramway manager the making of records which, if made public, would be of great use to the friends and to the enemies of electrical traction. In the main, the rules are about as sensible as could have been devised, but one or two assume the existence of a good deal of stupidity and ignorance. There might be some difficulty in actual practice to conform to the following rule: "The company shall so construct and maintain their system as to secure good contact between the motors and the line and the return respectively, and they shall not allow sparking to occur at the rubbing or rolling contacts." On wet slippery days it is usual to use sand on the rails to enable the wheels to get the necessary grip, but it is quite certain that if the rails formed part of the return there would be much sparking when the car passed over the sand. It may be found that other rules are too stringent in actual practice; but we take consolation from the knowledge that the Board of Trade is generally ready to modify irksome and useless conditions.

The Electro-deposition of Iridium.

IN recent articles by Dr. Wahl and Mr. Dudley, in the *Electrical Review* (American) on the electro-deposition of iridium, the use of a carbon anode (evolving an acid radical, *i.e.*, an anhydride and oxygen in electrolysis) with a metallic oxide or hydrate in contact with it, is put forward as a novel idea. We do not think, however, that there is so much novelty in the arrangement as the writers think. The plan is efficacious for the purpose in view—a metal *plus* oxygen being added to the solution—whilst the metal is deposited at the cathode and oxygen is evolved at the anode. The notion conveyed to the student by such papers as those of Mr. Dudley and Dr. Wahl is that the electro-deposition of iridium and platinum is a delightfully easy process; we can state, however, that this is by no means the case, though the process is easy in comparison with iridium deposition. It is all very well to be told to add an oxide or hydrate, but how are these to be prepared—not as chemical curiosities but on a practical scale? This we are not told. We know that the addition of alkali to platinic nitrate precipitates *half* the metal as oxide, but what are we to do with the triple compound (of HNO_3, Pt O_2, and KHO); which contains the remaining half? And, in the first place, how are we to get the nitrate? One would think that mixing solutions of Pt Cl_4 and Ag NO_3 would be certain to result in platinic nitrate; but the compound formed is a yellow basic salt—the *platino-chloride of silver*. A solution of platinic sulphate with nitrate of carium certainly does give platinic nitrate, but then how is *platinic sulphate* to be obtained. The only method appears to be to gently heat platinic chloride with H_2 SO_4, but, except in very skilful hands, the heating almost invariably results in the more or less complete reduction of the metal. This is only a sample of the difficulties met with in carrying into effect the processes put forward as *faits accomplis* in practice.

The Influence of Electricity on the Carburation of Iron by Cementation.

THIS extremely interesting subject has recently been investigated by Mons. Jules Garnier, who has communicated his results to a meeting of the Paris Academy of Science (*vide Comptes Rendus*, cxvi., pp. 1,449—1,451). Cementation is the name applied to the process by which metal bars, &c., are embedded in certain powders or "cementing" materials, and are then heated to a temperature below their fusion for a period varying between several hours and as many days. When charcoal forms the cementing material and malleable iron bars are under treatment the result is a carburisation of the iron and the production of blister steel; but if the cement powder be hæmatite iron ore, and the object for conversion be a casting of cast-iron, then the cementation process becomes one of decarburisation and the casting acquires many of the qualities of malleable iron. The first-named form of the cementation process is that to which M. Garnier has been directing his attention, namely, the conversion of iron into steel. This process has always been wrapped in much obscurity. Réamur was the first to study it; but, though that was many years ago, there are many important matters relating to it which have yet to be cleared up. Cementation is practised to-day on much the same lines as it was in the last century, and the process is always a lengthy one. Garnier's investigations were made with a view to hastening the process by introducing electric energy. His experiments and results are amply illustrated by the following:—A bar of steel containing only 0·1 per cent. of carbon and a rod of gas carbon were placed end to end in a refractory tube, and well insulated. The tube was then heated at 900°—1,000° C., and a current of 55 ampères and 7 volts was passed from the carbon to the steel. After three hours it was found that part of the iron affixed to the carbon had become so hard that it would cut glass easily, and a section showed that cementation had taken place to a depth of 10 mm., whilst the carbon was corroded at the surface of contact. Two bars of steel were then packed side by side in wood charcoal with a space of 10 mm. between them, and were heated to 900°—1,000° C. for three hours, a current of 55 ampères and 2·5 volts being passed from one to the other. It was found that the bar which served as the anode was practically unaffected, whilst in that which played the part of the cathode cementation had occurred to a considerable depth. It would seem, therefore, that at about 1,000° C. the cementation of iron takes place with very great rapidity under the influence of a weak electric current. We hope this matter will not be allowed to remain in *statu quo*, the interests involved appear to be too weighty. Not only do M. Garnier's results point towards a revolution in the cementation industry, they open out another new field for electric enterprise.

INDIA-RUBBER FOR DEEP-SEA INSULATION.

OPPOSING VIEWS IN THE TRADE.

IN the October issue of the *India-Rubber World*, our recent leader on "India-Rubber Insulation" was reproduced. In the number for November we observe an article, a copy of which we give below :—

"The article entitled 'Vindication of India-Rubber for Submarine Insulation,' reprinted in the last number of this journal from an English contemporary, was the subject of an interview, for the *India-Rubber World*, with Mr. Henry A. Reed, secretary of the Bishop Gutta-Percha Company (New York). This is an old and well known establishment, engaged in the manufacture not only of a great variety of gutta-percha goods, but also of India-rubber insulated wires for some purposes.

"'The article you reprinted from the London ELECTRICAL REVIEW,' said Mr. Reed, 'is misleading and grossly inaccurate from beginning to end. The writer of it shows throughout utter unfamiliarity with the very elements of the subject. Let us take up his allegations *seriatim*. He starts out by saying that indications are not wanting that there must be a limit to the supply of gutta-percha. Now the fact is that gutta-percha is more plentiful and cheaper in the market to-day than it was at any time in the last four years. It is produced as fast as it ever was. The demand is far greater, however, than in the past. Still, so long as it is as plentiful and cheap, relatively to former conditions, as it is now, all talk about the end of gutta-percha is ridiculous.

"'Next we come to the reference to "paper and other substances" coming to the fore as substitutes for gutta-percha. There has never been any effort made to use paper or similar substances for deep-sea work. Paper is used in crossing small streams or underground; what it does is merely to separate the conductor from the lead. As long as the lead remains intact, the wire is insulated, but lead is easily injured in deep water, and nobody is ever likely to think of paper and similar substances for submarine cables.

"'What the writer says with regard to the career of India-rubber in submarine telegraphy is true, and the account of the Hooper core experiments is doubtless substantially correct. The Hooper process is 20 years old, and there has been ample time to test its virtues and possibilities. Now in England, Germany, France, and elsewhere, rubber insulation for submarine cables has been experimented with, the results being always and uniformly unsatisfactory. Our own torpedo people have tried it, and have also failed. The simple fact of the matter is that no India-rubber compound has yet been made that will stand deep-sea pressure. Pure India-rubber would stand the pressure, but India-rubber cannot be used pure. It has to be adulterated for purposes of manipulation, and no compound remains waterproof under greater than ordinary pressure. Now we recommend rubber insulation for shallow waters and small streams. We make a cable compound similar to Hooper's, and we have used it for several years in water less than 400 or 500 feet deep. But in deeper water India-rubber insulation is impracticable. As for the story of the success of Mr. John P. Hooper with the cable between Cienfuegos and Santiago, it may be a striking and singular exception to the experience of everybody else, and if it really works as described, it is the only cable with rubber insulation that ever worked in deep water; but I am inclined to think it probable that that cable does not lie in *very* deep water.

"'Now let us see what the writer says about the alleged advantages of India-rubber for submarine cables. Rubber insulation, he says, renders the detection of faults of manufacture an easier and more certain matter. There is absolutely nothing in this. There is no difference between India-rubber and gutta-percha in this respect. Any absolute fault is easily located, while a weak spot merely is exceedingly difficult to locate. What is said about the teredo worm is true to some extent, though not for the reason specified. India-rubber will resist the teredo worm a little better than gutta-percha on account of the oxides and the adulteration entering into the compound, whereas gutta-percha should be and is used pure. Naturally the "surface" is attacked in either case, but after one surface has been destroyed, there is another, isn't there, for the worm to attack? What is said about jointing is absurd. Gutta-percha is generally used for joints, even on cables insulated with India-rubber, and whenever any mending is to be done, gutta-percha is used. The India-rubber joints have to be vulcanised, and hence there is always danger of over-vulcanising the rubber that comes directly in contact with the joints. A still greater absurdity is the statement that rubber core is not suitable for conditions of alternate wet and dry, and that it has failed when used as the leading-in shore ends of cables. Why, the fact is exactly the reverse of this. The shore ends *are* made of rubber, even in gutta-percha cables. Gutta-percha does not stand heat; it softens when the sun strikes it. It is not at all suitable for leading-in shore ends, on account of the variations of temperature, which it fears. Rubber is not afraid of conditions of alternate wet and dry; Hooper's core can be made to stand these changes as well as gutta-percha.

"'The statement that in respect of price India-rubber possesses no marked advantage over gutta-percha is equally wide of the truth. The very best India-rubber compound for insulation made is 40 cents a pound, while the best gutta-percha used is not less than $1.50 a pound. For the same kind of core India-rubber will cost you just about half of what gutta-percha is. The exhortation to the rubber manufacturers, therefore, to show that they can "compete" with gutta-percha in the matter of price is highly diverting. Rubber has an overwhelming advantage in that respect, and were it only possible to use it in deep sea insulation, were it as durable as gutta-percha, the latter would stand no chance whatever against it. But it is not possible as yet. And even in crossing shallow streams, where India-rubber insulation has been successfully used, the rubber does not last more than 10 or 15 years, while many gutta-percha cables are as good to-day as 20 years ago, when first laid.

"'But of course, if gutta-percha should go out, India-rubber would have to be used. It is certainly the next best thing'"

Mr. Willard L. Candee, one of the managers of the Okonite Company, Limited (New York), was also interviewed on the success of the Hooper's with India-rubber insulation in deep water.

"'I do not doubt,' said he, 'that the statements set forth in the ELECTRICAL REVIEW are correct, and I am not surprised at Mr. Hooper's success. India-rubber can be used in submarine work just as successfully as gutta-percha, and the general belief to the contrary is simply a widespread prejudice, nothing more. It is not supported by any facts whatever. Miles of India-rubber core are manufactured and sold, and doubtless some of it is used in deep water, although I am unable to refer you to any particular place where it is used. It is my opinion that India-rubber will work under deep-sea pressure, and the Hooper story confirms it.'

"'Why, then, is gutta-percha so generally preferred?'

"'Because people are prejudiced against India-rubber. Having become habituated to the use of gutta-percha, they will not give the other material a fair chance. The case is by no means exceptional. There was a general prejudice against the introduction of electric lighting when it was first tried, and to-day the irrational nature of that opposition can be clearly proved. People like to stick to good old ways, and it is not easy to get them to try something new.'

"'Is it not true, then, that India-rubber insulation has been tried both in this country and on the other side, and that it has been discredited by repeated failures?'

"'I am not aware of any such experiments or failures. When anybody talks to you about such failures, try to get them to give you particulars. I think you will find that there are few, if any, real facts behind these general assertions about the failure of India-rubber insulation in deep water. You say India-rubber has been tried by our torpedo people. Why, the Government has never sanctioned any attempt to insulate its submarine cables with India-rubber. It does not allow the rubber manufacturers to make specifications. It insists on its own specifications, and will have nothing but gutta-percha.'

"'Still, it is but reasonable to suppose that if India-rubber insulation really worked anywhere, the fact would become known, just as the Hooper success has become known. It would be natural for the manufacturers to announce their success, and thus vindicate India-rubber.'

"'Yes, the manufacturers would be apt to give publicity to such facts, but the purchasers often are unwilling to furnish the information to the public. It may be that there are to-day many deep-sea cables with India-rubber insulation. It is only a mere accident that Mr. John P. Hooper's success has become public property.'

"'It is claimed, Mr. Candee, that even in shallow water rubber is not as durable as gutta-percha.'

"'It is easy to make the claim, but not to substantiate it. Rubber-insulated cables have failed, of course, and so have gutta-percha cables. But you never hear of the failure of gutta-percha, because gutta-percha is not on trial and people do not jump at conclusions when they learn of damage to a gutta-percha cable. It is different with India-rubber. You are sure to hear of every case of damage as positive proof of failure. But it is prejudice—nothing else.'

"'How about the statement that rubber has failed when used as the leading-in shore-ends of cables? Is there any truth in that?'

"'That is manifestly a mistake. Gutta-percha is far more liable to fail on account of the changes of temperature, which are fatal to it. I have never known rubber to fail in that application except through mechanical injury.'

"'Has India-rubber an advantage over gutta-percha in respect of price?'

"'It has a decided advantage. You cannot ship gutta-percha core except in large tanks, to protect it from the changes of temperature, and this always adds materially to the expense. India-rubber core, on the other hand, you can ship in coils or in any other way at all.'"

Perhaps some of our experienced cable men on this side of the Atlantic will put forward their opinions regarding the views held by Americans.

THE STORAGE BATTERY QUESTION.

BEFORE the Franklin Institute a lecture on this subject was recently delivered by Pedro G. Salom. We do not consider the explanation of the lecturer as regards the state of the battery when discharged a very fortunate one, for if all the peroxide of lead had been converted into sulphate of lead, which is a non-conductor, no further action of the battery would be possible. As a matter of fact, this total conversion does not take place in an ordinary discharge, which is stopped at a certain P.D. limit, and in such case the sulphate of lead is mixed with unreduced peroxide, the mixture acting as a conductor, and thus enables recharge of the battery. Further, we fail to see how, if "the battery will positively refuse to work," any electrolysis of the electrolyte can take place.

The attempted proof that the Planté principle is wrong, as otherwise a mass of spongy lead and a plate of peroxide would form an ideal battery, misses the point, as the positive electrode in a Planté battery is not peroxide of lead, as such, but peroxide in intimate contact with metallic lead, or in other words the best possible combination of the active and conducting parts.

If the author speaks of the short-comings of batteries made on the Planté principle on account of their great weight or small capacity, he can only refer to the original old Planté batteries, entirely ignoring the progress which has been made by other inventors, who now produce batteries on an improved Planté plan, that is, using the original lead of the plate without paste, which batteries compare, in capacity and weight for weight, very favourably with any pasted plate.

The alleged possibility of increasing the active material in a pasted plate by making the cross bars of the grid further apart, is confronted by the difficulty of utilising slabs of active material which exceed a certain dimension, as in such cases, and especially with heavy discharge currents, only those parts which adjoin the grid enter into play, while the inner parts of such slabs do not contribute to the working of the plate, owing to their becoming more or less insulated by the layer of sulphate which forms at the edges of the slab.

As regards the first cost of the battery and cost of maintenance which are given for a 50-light plant respectively, at $1,000 and $250. These figures compare very unfavourably with those obtaining in this country, where such a plant would not cost more than one-half to two-thirds of the first-named price, and where the maintenance would vary between 7 per cent. and 10 per cent. of that smaller first cost, as against 25 per cent. of the cost in America, according to this authority.

Predicting, as the author does, that storage battery traction will ultimately supersede the trolley system for street car service, we fail to see why he makes an exception in favour of the trolley for suburban and country roads, which he assigns to it as its legitimate field. In the case of such roads, with cars running at long intervals, the economy of the accumulator system (its feasibility once granted), should render it the favoured rival.

Altogether, it appears from this authority that storage batteries as manufactured and used in the United States have not attained that state of comparative perfection which they have been brought to in this country.

HEDGEHOG TRANSFORMERS AND CONDENSERS.*

BY FREDERICK BEDELL, K. B. MILLER, AND G. F. WAGNER.

THE authors devoted the first part to the description of apparatus and measurement. The method of instantaneous contact was employed for obtaining the E.M.F. at various points of the phase, for which purpose the contact employed consisted of a needle attached to a revolving disc which cut through a fine stream of water at every revolution, and the potential difference was obtained by means of a multicellular voltmeter with a pneumatic damping arrangement, devised by Prof. Ryan. The Hedgehog transformer primary consisted of 1,426 turns of wire, 0·072 inch in diameter, arranged in twelve layers. Its resistance was 2·748 ohms, and its weight 29 pounds. The secondary consisted of 73 turns of cable composed of 19 strands of 0·058 inch wire, with a resistance of ·0149 ohm, and weighing 12·5 pounds. The transformer was designed for 1,000 volts at 130 periods.

Experiments show that at no load the lag of the primary current behind the primary E.M.F. is almost 90 degrees, which is greatly in excess of the lag shown by similar experiments upon transformers with closed magnetic circuits. The secondary E.M.F. at no load is almost opposite in phase to the primary E.M.F., that is, almost 180 degrees behind it. With increased load the lag increased slightly, due to increased leakage. The curve for efficiency rises very rapidly as the load increases, reaching 90 degrees at about $\frac{1}{8}$th of full load. From $\frac{1}{4}$ load it is nearly constant, rising to 96·6 per cent. at $\frac{2}{3}$rds load. It remains practically constant until full load is reached and then falls off slightly on overload. The all-day efficiency calculated on a basis of 5 hours at full load out of 24 hours is 91·8 per cent. There is a fall of about 2·5 volts in the secondary between no load and full load.

Tests were then made with Stanley condensers in circuit and readings taken for determining the primary E.M.F., secondary E.M.F., primary and line current. The results of three runs are given in the following table, showing clearly the effect of the condenser in diminishing the line current, especially at no load.

Lamps in secondary.	Primary current.	Line current.
0	·95	·187
15	1·24	·867
45	3·07	2·73

At no load the line current is seen to be less than $\frac{1}{5}$th of the primary current, or the value it would have if the condensers were absent; even under full load the reduction is considerable. As the results of these tests the authors conclude that the transformer upon which the investigation was made, possesses two valuable features, high efficiency and good regulation. The experiments with the condensers, demonstrate the practicability of their use to diminish the line current in transformer circuits, and points to their more extended use, as their manufacture is perfected and cheapened, not only in this, but also in other systems of alternating current distribution.

* Abstract of a paper read before the American Institute of Electrical Engineers, October 18th, 1893.

THE NEW SYSTEM OF ALTERNATING CURRENT AND TRANSFORMER DISTRIBUTION.

By RANKIN KENNEDY.

IV.

HIGH-PRESSURE QUADRATURE GENERATOR.

The author's high-pressure machine is illustrated in figs. 6 and 7. In this machine all the coils are fixed and the polar projections revolve.

Referring to the figures, C in fig. 6, is the cast-iron magnetic shell of the field magnet; K, is a laminated fixed core carrying the armature coils, D, D. A is a brass sleeve between the armature and shaft, B is the revolving inductor carried on bolts through E, E.

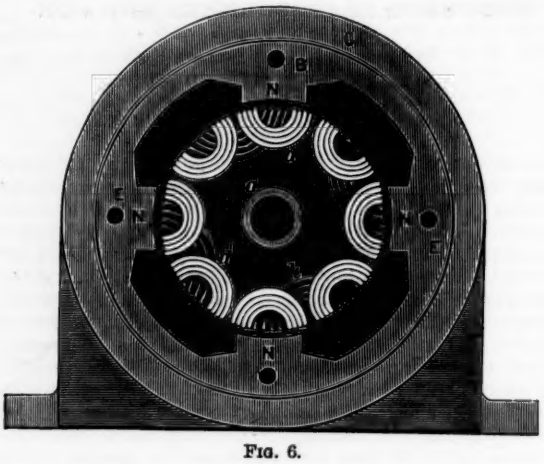


FIG. 6.

In fig. 7, the field magnet C is seen in section; F is the star carrying the inductors, B. The armature core is made up of a core of soft iron, K, with a laminated surface next to

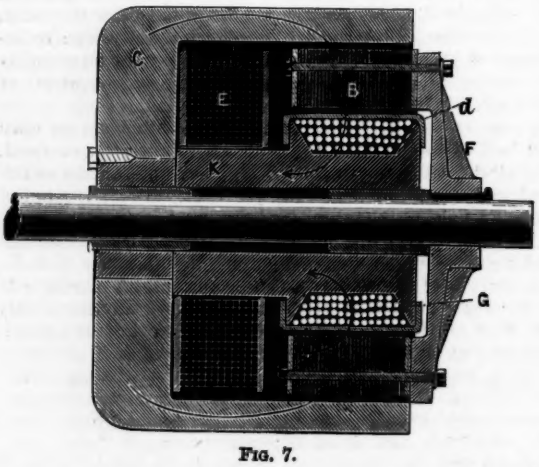


FIG. 7.

the inductors; E, is the exciting coil next to the end of the magnet shell.

The poles on the inductors are all similar. The coils on armature are laid on flat, or into slots, and, being fixed, are easily insulated to any extent.

The machine illustrated is a small one with four poles only. It will, however, be obvious that such a design will be very easily carried up to any size whatever.

With this class of machine the frequency is equal to the number of poles multiplied by the number of revolutions per second. There are two series of coils on the armature, eight coils in each series.

The star, F, carrying the inductors, B, in fig. 7, is made of brass for small machines, and of manganese cast steel for larger sizes.

This dynamo produces two alternating currents in quadrature phase, and is designed for long distance transmissions up to 20,000 volts. It requires to be excited either by a separate continuous current machine, like other alternators, or by the two currents rectified, as before described, to form a continuous current.

Dynamos of this class are not of so much interest to us just now as those described in the previous article; for general purposes it is preferable to use the continuous current dynamos fitted with quadrature collecting rings. We can, by using the continuous current dynamo at the generating station, obtain the advantages of storage and direct supply—very great advantages.

The dynamos we shall find preferable are designed exactly as ordinary first-class continuous current multipolar dynamos, so that we need not enter further upon the subject of the generators, having pointed out what has to be done to obtain the quadrature currents from well-known machines.

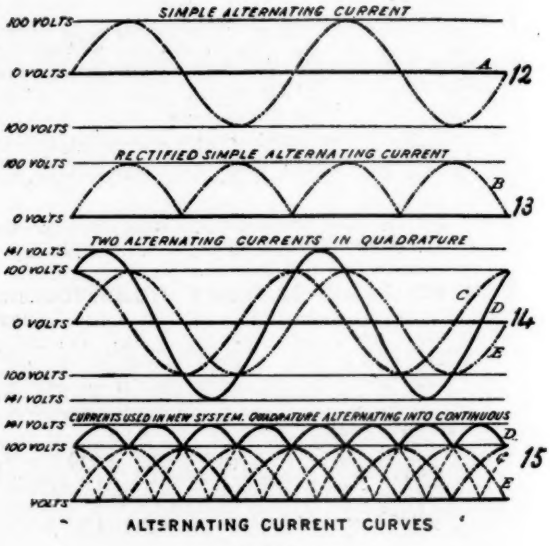


FIG. 8.

Alternating currents derived from continuous current dynamos by this method rise and fall in true "sine curves"; in this they are superior to ordinary alternators inasmuch as ordinary alternators do not give currents following the sine curve, and, therefore, calculations are generally only approximately correct when made on the assumption that the sine curve represents the current in an ordinary alternator. With our new currents the sine curve is followed exactly so that all calculations made on that assumption come out correct.

In fig. 8 we have curves representing the various currents. First at A, we have a single-phase current rising and falling through 100 volts; at B, we have the same curve rectified into a unidirection pulsating current; this is the curve we get by commutating a single-phase alternating current, it is not a continuous current. C, D, E, are three curves of quadrature current; C is one of the quadrature currents and E, the other one, the one is at a maximum at the instant the other is at a minimum; D represents a current or P.D. obtained by sending two currents in quadrature in series through the same conductor, giving us a current not equal to the sum of the other two, and out of phase with both of them. This curve, D, is one which we will again refer to.

The last group of curves shows the combined rectified quadrature currents; C, E, are the two rectified alternating currents; D is the rise and fall of the combined currents. It will be seen that the fall is never below 100 volts, and the maximum is 141 volts when the maximum of each current,

C and E, is 100 volts. These curves show us the nature of the continuous current produced by combining the two quadrature currents in series when rectified.

At the generating station the 120 volts continuous current circuits of the dynamos is intended to supply all the continuous current required in the immediate neighbourhood and in the station for storage purposes. In this new system storage is to be used largely, not only to supplement the continuous current circuits, but also to supplement the alternate current supplies and the dynamos when not fully loaded, by direct running into the mains, are to be kept up to full load by charging the storage batteries.

By properly arranging the dynamos and engines and the storage batteries at the generating station, it is not a difficult matter to keep the machinery running at or near full load all the time; that means great economy and a large supply from a small amount of machinery. The first method of using storage batteries at the central station for the purpose of supplying the alternating circuits as well as the continuous circuits is very simple, and that is a fact of very great importance, because it is upon the alternating circuits the new system principally depends for its success. The continuous currents generated by the dynamos cannot be sent far from the station for the supply of continuous current at a distance. On the new system the electrical energy is carried to the distant places by two alternating currents in quadrature phase, and at the distant place these are converted into continuous current for the supply. The direct continuous current supply from the dynamos extending only a short distance from the station would not be a large supply, while the alternating high-pressure supply, extending to all distant places and carrying large supplies, would be the chief circuits.

On the new system it is, therefore, imperative that the stored electrical energy can be drawn upon to feed the high-pressure alternating supply mains if storage is adopted.

The charging of the accumulators is effected in the usual manner from the 120 volts circuit of the continuous current dynamos; this process does not require any description either, but the discharging of the accumulators into the high pressure quadrature mains has never been described, and forms an essential part of this new system, so that we shall now see how this is accomplished.

This discharging can be accomplished in two ways; first, by a reversed quadrature generator; secondly, by a commutator driven by a synchronous alternating motor.

Referring again to our typical quadrature generator, fig. 10,

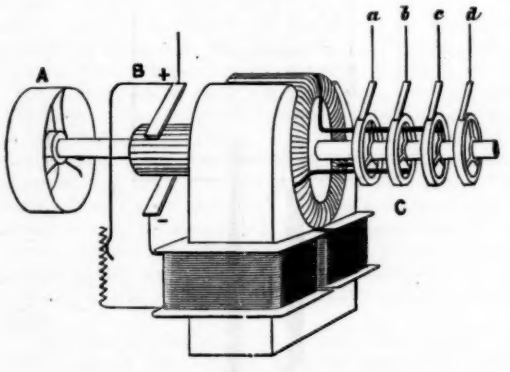


FIG. 10.

a storage battery is connected across the terminals of the continuous current circuit at B. The dynamo is shunt wound and is driven at pulley, A, to charge the battery.

Now suppose the belt to be thrown off at A, the dynamo will still run on as a motor driven by current from the battery, and we could draw two alternating currents in quadrature from the rings, *a*, *b*, *c*, *d*; these quadrature currents come from the storage battery.

At our generating station as many dynamos are placed without engines or other driving gear as may be required to run off the storage battery into the step-up transformers to supply current in times of heavy demand, and at all times a certain portion of the load is to be run from the storage batteries, to make use of the stored energy laid up during the light load periods.

Now, it is a very remarkable fact, not generally known, that a dynamo running from a storage battery or other supply in the manner herein described, that is, as a motor converting continuous into quadrature current, can give, without heating, about twice the output as quadrature current that it can give when worked simply as a dynamo by a belt. This is easily accounted for: at the moment the alternating current reaches a maximum it does not pass through the armature at all, but direct from the brushes at B to the rings at C, the currents passing through the armature coils are rapidly diminishing after the coils pass from under the brushes, so that the mean current in the armature is only about half the current from the brushes.

Fig. 9 is a diagram of a plan drawn up by the author for distributing electricity over the whole city and suburbs of Glasgow by the new system. The scheme is, of course, too large and comprehensive to be taken up just at present, an experiment with a small low-pressure scheme on the continuous current system being as far as the authorities could go.

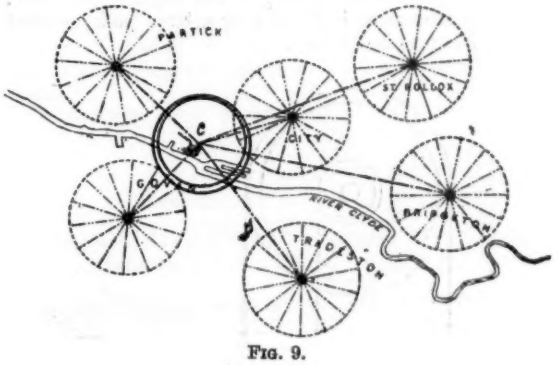


FIG. 9.

Referring to the figure, the heavy circle surrounds the generating station, C. Inside of this radius everything would be low pressure, whether alternating or continuous. The generating station would, in all probability, be situated where land was cheap and carriage by water available, and so would not likely be in a position where a large direct supply could be made; but it might be in a place where a considerable amount of electric power could be sold, so that the two-phase currents could be supplied direct to drive two-phase or quadrature motors.

In the various districts represented by a circle, sub-stations would be laid down to supply these districts; six sub-stations are represented in our diagram. These six sub-stations would receive their supplies from the generating station, C, in the form of high pressure quadrature currents through high pressure mains, shown by the six lines radiating from the station, C, to the centre of each circle.

At each sub-station only converters and transformers would be laid down. Transformers to reduce the pressure of the quadrature currents to 120 volts and converters to convert as much as was required into continuous current for arc lamp or other purposes requiring such current. But the chief supply would be alternating current run direct from the sub-station transformers. These sub-stations would require very little attention, having no engines, boilers, or dynamos to keep in order.

Thus the general scheme may be summed up. At the station the boilers and engines, or other motive powers the dynamos, step-up transformers to feed the high pressure transmitting mains, storage batteries, and all regulating devices, are placed under one staff and control. (This is very much like the Deptford scheme of distribution in London; there, however, only single phase currents are used, and hence no advantage can be taken of these improved methods and apparatus; yet it is quite possible to make the Deptford system into a quadrature system, and so extend its usefulness.)

The supply is carried to the sub-stations by high pressure mains, and from there distributed as low pressure alternating and low pressure continuous current, single phase, quadrature and continuous currents, to meet any requirements.

C

At the generating station the arrangements are much the same as in continuous current generating stations where multipolar dynamos are employed, with the addition of the step-up transformers for supplying the high pressure quadrature currents to the mains running out to the sub-stations. These step-up transformers may be ordinary transformers, such as can be had from makers of transformers for the single-phase circuits now in use, separate transformers are to be used for each current; later on a special transformer shall be described for the purpose.

THE SCIENTIFIC STUDY OF ARC LAMPS.

By RANKIN KENNEDY.

IV.

FIG. 21 is a differential geared clutch lamp designed by the author.

This clutch is hung on a strap winding over a small pulley, and is of the washer type, but has a long tail piece with an adjustable screw to adjust the height of the feed; the feeding movement is hung over a large pulley, so that great sensitiveness is obtained.

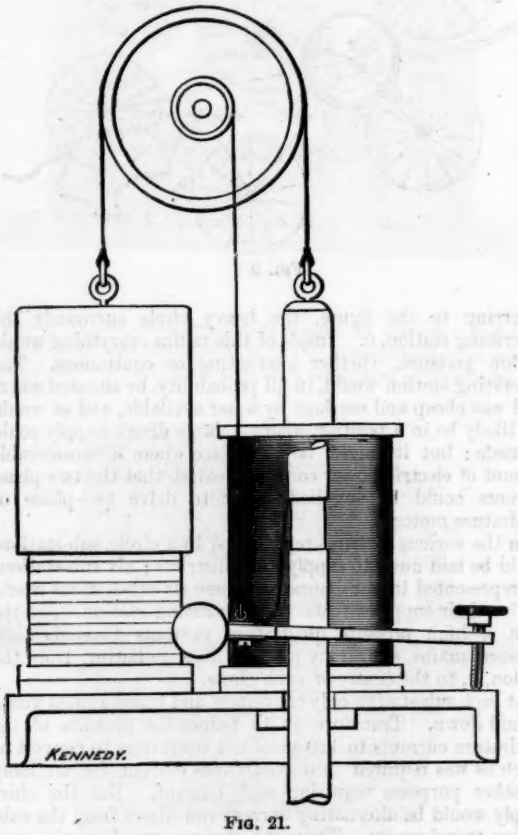


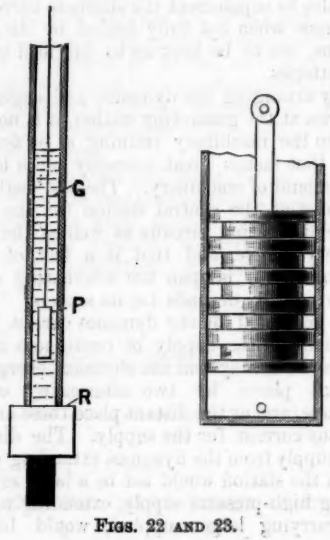
FIG. 21.

In this lamp, and in all clutch lamps of this type, it was found necessary to introduce a dash-pot to break the fall of the rod through the clutch when released; this dash-pot allows of a slow even feed, and is to be found in most American arc lamps.

The dash-pot has been long ago abandoned in this country, so far as its action on the carbon rods is concerned. A dash-pot is still necessary (although many lamps have none), but it is only attached to the electrical gear to damp any sudden jerky movements in the magnet cores or armatures, and plays only a very subordinate part in the regulation of the best lamps.

In those lamps in which the carbon holder rods work in dash-pots, the dash-pot performs the most important functions, and as dash-pots are not reliable enough for the purpose, lamps of that class are not as a rule successful. The dash-pot is apt to get out of order when made of such a great length as is necessary in lamps where the rod contains the dash-pot.

Dash-pots were at first filled with glycerine, in which the plunger worked, as in fig. 22, where R is the lamp rod filled with glycerine, G. P is the plunger; the rod, R, is retarded in its descent by the slow passage of the glycerine past the piston, P.



FIGS. 22 AND 23.

Sometimes the tube, R, is a smooth bore with a piston fitting it nearly air-tight, so that the fall of the carbons is retarded by the slow passage of the air past the piston. This arrangement is called an air dash-pot, and has been dignified by American makers by the name of an "air feed."

Dash-pots are usually found in non-focussing lamps wherein only the upper carbon moves, and the lower one is fixed; in that case the whole weight of the upper carbon holder and

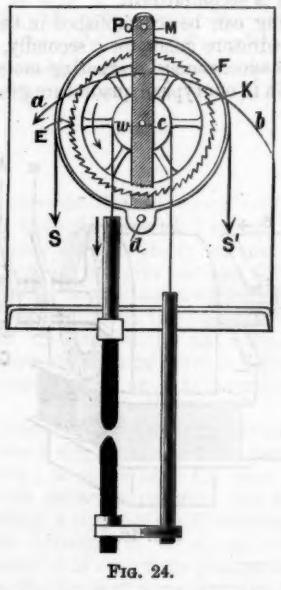


FIG. 24.

rod is unbalanced, so that when released by the clutch the heavy unbalanced rod and carbon would fall quickly, hence the necessity for an air or glycerine dash-pot in these lamp mechanisms.

A short air dash-pot is necessary in almost every lamp mechanism in connection with the moving armatures, such as is shown in fig. 23; here the cylinder, C, is bored smooth and fitted with a piston, *p*, which is corrugated or grooved to lessen friction, and yet present a long passage for the air to be retarded in squeezing past the clearance between the piston and cylinder.

The bore of the cylinder in these short dash-pots should be wide, never less than $1\frac{3}{8}$ inch or $1\frac{1}{4}$ inch; how and where these short dash-pots are applied, we shall see later on. Fig 24 is a step-by-step arc lamp feed mechanism of the author's design; the two carbon holders are hung over a rack wheel, *w*, by a rack chain; this rack wheel is on the same spindle as a large fine toothed wheel, K, so that both move together. A ring, F, carrying a spike, E, which engages in the teeth of the large wheel and pivoted on a shaft, *d*, carried in a swinging frame, *m*, swinging on centre, *c*, concentric with the toothed wheel.

On pulling down at S^1 it is obvious that the spike, *e*, will engage wheel, K, and the whole frame, *m*, ring, F, and wheels, K and *e*, will move round and part the carbons, thus forming the arc. As the arc increases in length the pull at S will preponderate over the pull at S^1 until the frame, *m*, comes against a stop, P, as shown in the fig. 24. And now any further increase in the length of the arc will cause the pull at S to disengage the spike by swinging the ring, F, on centre, *d*, as shown by the arrow, *a*, *b*, thus allowing the carbons to approach, wheel, K, moving round one tooth in the direction of the small arrow.

The pull downwards due to the weight of the upper carbon holder is adjusted by weighting it until it is about 2 ounces heavier than the lower carbon holder. This pull is represented by the small arrows, and is obviously acting in concert with any pull applied to S to feed the lamp carbons together. Now, at the instant that the spike is disengaged this weight ceases to act with the pulling force at S, hence S^1 immediately preponderates and pulls the spike into the next tooth, thus feeding only one tooth at a time.

This is a positive mechanical action, and the whole mechanism is locked until the spike is disengaged; so that such a lamp is capable of being swung about or vibrated violently without disturbing the fineness of the feed. The wheel, K, is made exceedingly heavy, so that by its inertia the movement of the carbons together is retarded when the wheel is disengaged.

SAFETY SYSTEM OF ELECTRIC WIRING.

THE two following letters appear in the N.Y. *Electrical Engineer* just to hand:—

"I am delighted to see that Mr. Kintner has devised a system of wiring which will render accidents to life and damage to property from the deadly isolated plant a thing of the past. It will hardly detract from the admiration which must be accorded so beautiful and necessary an improvement in the art to know that Mr. Andrews, in England, has had in use for some years a concentric system of wiring in which all the difficulties of such a system have been practically worked out. Mr. Andrews's system, it is true, is too expensive for 'these United States,' and could only be worked in a country where there is a class of customers who appreciate, and are willing to pay for, the best work that can be done. Judging from the cut and Mr. Kintner's reference to 'removable covers,' his system will have the advantage over the Andrews system of cheapness with a proper degree of nastiness to suit the palate of those who have done so much to bring electric lighting into disrepute with the underwriters.

"The idea of magnetically locking the brushes of a dynamo against interference while in operation, might at first thought be believed to belong to Mr. Ferranti. However, it must be admitted that Mr. Ferranti never thought of so locking the exposed electric conducting parts of a low tension dynamo, the only kind in use in 'buildings supplied with electric light plants.' Mr. Ferranti's absorption in 10,000-volt dynamos would account for his failure to apply the idea to dynamos from which a baby could take shocks without discomfort.

"Seriously, electricity is no longer in its infancy, if some electricians are. We have had too much of 'taking the other fellow's dynamo and painting it red,' and taking the other fellow's hard-earned and well-worked out practice and 'revising' it into a 'system'—on paper.

"CHARLES WIRT."

"I have been much interested in Mr. C. J. Kintner's paper on the 'Safety System of Electrical Wiring' in your issue of November 1st. The system proposed by Mr. Kintner seems unquestionably to be an excellent one. It occurs to me, however, that the chief features in Mr. Kintner's system were present in the system devised by Mr. S. Z. de Ferranti as early as 1889, or possibly earlier.

"The principle of the Ferranti concentric cable is probably familiar to almost all of the electrical fraternity, and was, at the time of its first introduction, the subject of much discussion. It is to this very Ferranti cable that we owe the remarkable and, for some time, inexplicable 'Ferranti effect.' The boxing in of the commutator and brushes with the magnetic locking of the enclosing case at such times as the generator is in operation, was also both proposed and practised by Ferranti, it being his intention to have all the machines in the great Deptford station so constructed.

"In a paper read by myself before the National Electric Light Association's Convention in Providence, in 1891, I made mention of, and partially described, both the concentric conductor proposed, and to some extent used by Ferranti, and also the magnetically closed box surrounding the brushes. It is true that Mr. Ferranti did not propose to surround a commutator with this box, since Mr. Ferranti's machine was an alternator. In other respects, however, it seems to be distinctly similar in general plan. It was also Mr. Ferranti's intention to ground the outer conductor of his concentric cable, thus eliminating any possibility of a discharge or static shock.

"I trust that I may be pardoned for calling attention to what is perhaps a half forgotten matter.

"CARYL D. HASKINS."

SOME RECENT DEVELOPMENTS IN ALTERNATING CURRENT MOTORS.

BY ELIAS E. RIES AND GORDON J. SCOTT.*

AMONG the most interesting and valuable features that characterised the work of the International Electrical Congress recently held in connection with the World's Fair at Chicago, were the remarks made by many of the distinguished delegates present upon the subject of the transmission of alternating currents, and the respective merits of single and multiphase motors for power distribution. Although opinions were somewhat divided upon this latter question, it was clearly recognised that the multiphase systems at present available [employed] were merely an expedient rendered necessary by the existing state of the art, and that the advent of a simple and efficient self-starting single-phase alternating current motor would at once establish the latter as the standard type for nearly all classes of electrical power distribution.

In the course of some extended experiments made by us upon the subject recently, we have discovered, and practically demonstrated, a number of important facts which, in many respects, revolutionise the theories that electricians have heretofore held, and have been accustomed to regard as essential principles in the design and construction of alternating current motors. These discoveries, which promise to inaugurate a new departure in alternating motor construction, have shown us that it is not only possible to construct self-starting non-synchronous alternating current motors *of any desired power* that will run economically on single-phase circuits *of any commercial frequency* (such, for example, as that in common use for incandescent lighting), but that such motors will be, everything considered, *far more efficient*, both electrically and mechanically, than the best continuous current motors yet produced.

The difficulties hitherto encountered in attempts made to construct self-starting variable speed motors intended for operation on ordinary alternating current incandescent lighting circuits, have apparently been of an insurmountable nature. With the exception of the smaller types of motors developing a fraction of a horse-power, such as those used for operating small ventilating fans, where economy in the use of current has been considered of minor importance, and

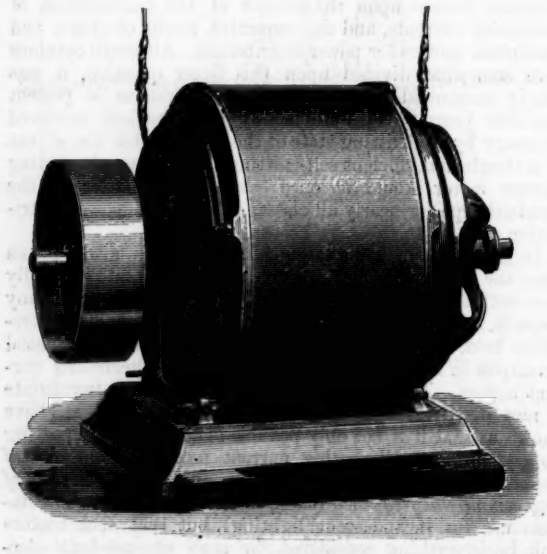
* We are indebted to the authors for an advance proof of this paper.—EDS. ELEC. REV.

in which the self-induction in the energising coils and the losses in the magnetic circuit could be kept reasonably small, all attempts to produce efficient motors to operate on a simple two-wire alternating circuit, without the employment of more or less complicated auxiliary starting or lag-changing devices, have thus far failed. Even two-phase and polyphase motors, as at present constructed, although self-starting under light loads, require for their efficient operation not only a low frequency that unnecessarily increases the size of the generating, transforming and motor apparatus, and which renders it in many cases unsuitable for lighting purposes (to say nothing of the greater complexity of the feeding and distributing mains which such a system involves), but owing to the great sacrifice in electrical and mechanical efficiency when their normal speed is departed from, such motors cannot compete with direct current motors for work where a variable speed with maximum torque is requisite, as, for example, in the case of electric street railways.

Following up our researches in the alternating motor field, and with the view of producing a motor of simple construction that could be operated on any of the commercial alternating current circuits now in use, with reasonable economy, we built a number of experimental motors of various types and sizes embodying some of the results of our investigations. These motors have been thoroughly tested in the factory of the Ries Electric Specialty Company, at Baltimore, and the results obtained have been so successful that we are now making preparations to build alternating current motors for commercial uses that, in the matter of efficiency, simplicity, weight, adaptability and general excellence of operation will compare favourably with, if, indeed, they do not in these respects surpass, all existing types of electric motors.

Believing that the remarkable results we have already obtained will be of general interest at this time, we have thought it advisable to present herewith a photograph of one of the single-phase motors built and used by us in some of our experiments, together with such information concerning its operation as we are at liberty to disclose at present.

The motor illustrated has a capacity of 1 H.P., and was designed for, and tested upon, an ordinary 50-volt alter-



nating current incandescent circuit having a frequency of 138 complete cycles per second. The most noticeable feature is its extremely small size and weight for a motor of its output and efficiency. The total height of this motor, including base, is 9½ inches, the diameter of the motor proper, 9 inches; the width of motor, exclusive of end plates containing bearings, 5 inches; the total length of armature shaft, 11½ inches; while the *total weight is but 35 lbs., of which only 2 lbs. are copper.*

Actual brake measurements were made upon this motor, while the same was running at various speeds on an ordinary 50-volt incandescent circuit of 138 complete cycles per second. At a speed of 2,000 revolutions per minute, taking 15 ampères of current, the motor developed 26,400 foot pounds, or ·80 horse-power, at an electrical efficiency of 90 per cent., the motor remaining perfectly cool after a continuous run of eight hours. With 10 ampères of current the power developed was 17,850 foot-pounds, or ·54 horse-power, *with an electrical efficiency of 93 per cent.* On increasing the load on the motor and thus reducing the speed to about 1,000 revolutions with the same flow of current, the power developed was substantially the same as before, with very nearly the same efficiency. When the speed was reduced below 600 revolutions, however, the efficiency dropped appreciably, although not enough even in the case of the present high-speed machine to detract from its usefulness for continuous and effective work at speeds very much below those hitherto found practicable in direct current work.

The diameter of the driving pulley is 5 inches, yet notwithstanding this, the torque developed by the motor is so great that it starts off promptly under full load. The speed of the motor, as has been fully demonstrated by these tests, is variable within wide limits, and without appreciable loss in efficiency, a result that has not heretofore been obtainable either with direct or alternating current motors. Another and most valuable characteristic of one type of the motor under consideration is that with a given flow of current the torque increases, up to a certain point, as the speed decreases. This peculiarity is likewise entirely new, and of the utmost importance, since it not only provides an exceedingly high starting torque, but enables the motor to develop its maximum power continuously at the highest possible efficiency, and irrespective of the speed at which it may run.

It will at once be apparent that these features render this type of motor particularly applicable for all stationary and railway work where widely fluctuating loads are encountered, especially so, because the principles underlying its construction are such that, unlike direct current constant potential motors, it cannot of itself receive more than its maximum normal current under any conditions of use, and thus cannot possibly be burned out or injured by an excessive overload, or by any of the other causes which have proven to be such prolific sources of trouble in the case of continuous current motors.

Perhaps the most remarkable feature about this machine is the fact that the losses and other difficulties that have heretofore attended the use of comparatively high frequencies for alternating motor work, whether single-phase, two-phase, or polyphase, have been practically eliminated. Indeed, were it not for this discovery, the results here recorded could never have been obtained. It is, perhaps, not too much to say that this achievement, to which we have successfully directed our strongest efforts, will contribute largely to the adoption of higher and more economical frequencies for alternating current work than those at present in vogue, or at least to the maintenance of the highest of the standard periods now in commercial use on lighting circuits, thus deservedly checking the precipitate and ill-advised tendency which is at present more or less prevalent not only abroad, where multiphase systems have for some time been extensively used, but in this country as well, to adopt as a standard for general use a current of such a low frequency as would involve not only much larger and more expensive generators, transformers, and motors, but which would prove unsatisfactory and uneconomical in the highest degree for nearly every purpose to which it can be applied.

Since high frequency in alternating current apparatus is the equivalent to high speed in direct current apparatus, in being the seat of the direct and counter-electromotive forces developed; and since it is well known that by increasing the speed of a direct current armature the output of the machine for a given amount of iron and copper is very much increased, it follows that the higher the frequency that can be used, the better the result obtained from an alternating current motor of a given size and weight. While there are serious mechanical limitations to higher armature speeds than those now in use, there are, so far as the motor is concerned, no longer any restrictions to the use of higher frequencies, since the self-induction and hysteresis, which in all previous types of alternating current motors have been the principal sources of loss, are now for the first time utilised in our motor, and turned to practical account, as shown by the fact that the

motor runs perfectly cool, despite the small quantity of iron and copper in the machine. Thus on circuits of higher frequency the alternating current motor will possess not only an enormous advantage over its continuous current brother, in the matter of safe and economical transmission over long distances of the power that gives it its vitality and scope, but will be far superior to it as a motor by reason of its more simple and compact form, and the correspondingly increased amount of power it is capable of generating per unit of weight under those conditions.

In addition to the motor illustrated herewith, we have built other single phase motors of larger sizes that are now doing successful work in the factory of the Ries Electric Specialty Company, where they can be seen in operation. Some of these motors are designed for synchronous working, and run at a constant speed under varying loads. As in the case of the variable speed motor, they are self-starting, and run rapidly up to synchronism without the use of a special starting coil or switch, and will automatically regain synchronism should their speed be temporarily reduced below it by reason of a heavy overload.

We are now able to predetermine the characteristics of our motors with as much accuracy as with direct current machines, and as already stated, we are rapidly completing the designs for a full line of these motors, ranging all the way from a small size ½ H.P. alternating fan motor, to the largest motors that may be required for stationary work. We have now likewise, in course of construction, a single phase high frequency alternating current railway motor of 40 H.P. capacity, which will have less than one-half the usual weight, and will embody some novel features peculiar to itself that are likely to have an important bearing upon the future of the electric railway.

To those who have been accustomed to the behaviour of direct or continuous current motors, or to those who have regarded the continuous current as the only practicable and economical one for power purposes, the remarkable performance of these motors, and the simple manner in which these results are obtained, is little short of marvellous. The comparatively high frequency of the alternating current used, the adaptability of the motors to ordinary single phase circuits, the exceedingly small size and weight of the motors compared with direct current machines of similar capacity, the absolute reliability of their operation, the extremely slight internal losses in the machines, to which their unusually high efficiency is largely due, and the great simplicity of their mechanical and electrical construction, in short, the radical departures made by us in the entire design of these motors, regarding which we hope soon to be able to publish full details, causes these motors to excel in every respect all that has yet been accomplished by the continuous current motor, and far surpasses in its reality the most sanguine expectations of even the foremost advocates of the transmission of power by alternating currents.

THE DE LAVAL STEAM TURBINE.

OUR special Commissioner to the World's Fair gave an account of this turbine a few weeks ago; there were many details, however, that he was unable to obtain. We are able to supplement these details from an account that recently appeared in the *Scientific American*.

This steam turbine is in principle exactly similar to the well-known axial jet turbine for water, being so arranged that the steam has acquired the same pressure as the surrounding atmosphere before reaching the turbine wheel, thus converting its entire capacity for work into momentum.

The steam passes between the blades of the turbine at a constant relative velocity and in a clear jet, without any disposition to further change its pressure or specific gravity. The consequence is that the movement of the steam in the turbine is according to the same laws as for water, and the blades of the turbine can, therefore, be constructed in the same manner as if designed for water.

The turbine shown in fig. 1 is all contained in the small case, F; B is the governor valve box; C, the bearing carrying the end of a flexible shaft; D is the exhaust pipe; E is a case containing gearing to reduce the speed. The turbine is driving a double armature dynamo, which serves to balance the gearing.

Some idea of the size of the steam turbine may be obtained

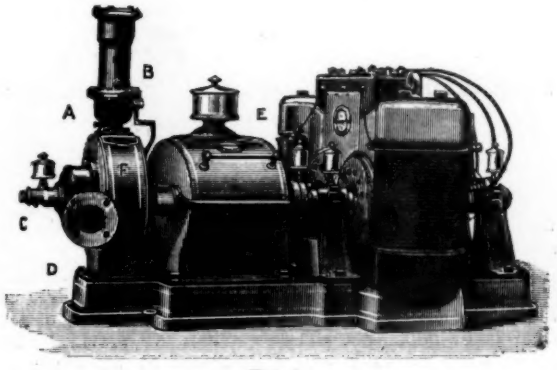


FIG. 1.

by reference to fig. 2, which represents two-fifths size, the wheel of a 20 horse-power steam engine. This wheel is journalled in a steam-tight casing, in which are located the nozzles supplying steam to the turbine. The blades against which the steam strikes are made thin at the edge, to reduce the resistance to the flow of steam. In this turbine steam is expanded to the pressure of the surrounding medium before arriving at the blades. This expansion takes place in the nozzle, and is caused by making the sides of the nozzle divergent. As the steam passes through the nozzle, its

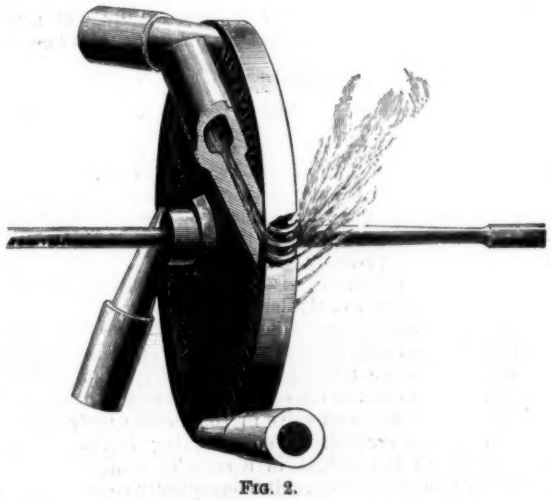


FIG. 2.

volume is increased in greater proportion than the cross section of the jet, thus causing an increase in velocity. With an initial pressure of 75 lbs., and an expansion to the pressure of one atmosphere, the final velocity of the steam is about 2,625 feet per second. If the expansion is continued to the pressure of one-tenth of an atmosphere, the resulting velocity will be about 4,600 feet per second. It will thus be seen that expansion is carried much farther in this steam turbine than in ordinary steam engines.

The wheel is made of steel, the blades being cut out of the solid material by means of a milling machine. A steel ring is shrunk on the periphery of the wheel, to prevent the steam from passing over the ends of the blades. It also serves to oppose the tendency of the turbine to act as a fan.

With the greatest possible care it has been found difficult to perfectly balance the wheel. To meet this difficulty the inventor has placed the wheel upon a flexible shaft, so that the turbine when running at a high rate of speed adjusts itself and revolves on its true centre of gravity, the centre line of the shaft meanwhile describing a surface of revolution. If the shaft were rigid, the vibrations of the turbine wheel would be communicated to its bearings, which would heat and be liable to cutting.

The turbine wheel-shaft extends into the gearing box and carries a pinion marked 1, on fig. 3, as shown in the detached view of the wheel and shaft. This pinion, which is double, engages a double cog-wheel in the box, the pinion on the turbine shaft being one-tenth the diameter of the driven

Fig. 3.—TURBINE WHEEL, SHAFT, AND PINION.

wheel, so that the speed of the latter is one-tenth of that of the turbine wheel, or 2,000 revolutions per minute.

In the gearing box of a larger turbine the speed is reduced from 30,000 revolutions to 3,000 by means of a driver on the turbine shafts, which set in motion a cog-wheel of ten times its own diameter. These gearings are provided with spiral cogs carefully cut and placed at an angle of about 45°. On account of the high velocity, all tensions caused by the transmission of power are very slight; consequently, the cogs can be quite small, which is one of the conditions for even running of the gearing. The shaft of the larger cog-wheel, running at a speed of 3,000 revolutions, is provided at its outer end with a pulley for the further transmission of power.

The turbine box of the large machine contains eight nozzles, of which four can be opened or closed by means of independent valves, according to the power required. The more exact regulation is effected by the governor. The turbine, therefore, can be made to work at the same pressure and degree of expansion even if the effect is varied as 2 : 1. The nozzles are easily accessible for removal and

NOZZLE.

exchange, if required. The journals and gearing are lubricated from the oil cups on top of the gearing box. This machine is intended to work with condensation. A vacuum is obtained by means of any ordinary condenser. The nozzles are strongly divergent toward the opening, and the entire turbine box made perfectly tight.

The speed of the turbine is controlled by a very sensitive governor on the shaft of the larger gear wheels.

The segment weights or wings are movable on knife edges with the least possible friction. When the governor revolves, the weights diverge their inner ends, push a pin forward, this pin in turn causing the cut-off of the steam through the movement of a balanced valve in the steam supply pipe at the top of the turbine. A spiral spring inclosed in the governor keeps the weight in a state of equilibrium at a speed of 3,000 revolutions. It consequently corresponds to the weight of the collar on pendulum governors. The exhaust steam is taken from the centre of the turbine box.

This turbine is applied to all uses to which ordinary reciprocating engines are applied, but in the running of dynamos, and in other uses requiring uniform speed, it has proved itself superior to reciprocating engines.

REGULATIONS FOR ELECTRIC TRACTION.

Draft regulations made by the Board of Trade under the provisions of the ——— Tramways Act, for regulating the employment of insulated returns, or of uninsulated metallic returns of low resistance; for preventing fusion or injurious electrolytic action of or on gas or water pipes or other metallic pipes, structures or substances; and for minimising, as far as is reasonably practicable, injurious interference with the electric wires, lines, and apparatus of parties other than the company, and the currents therein, whether such lines do or do not use the earth as a return.

Definitions.

In the following regulations—

The expression "energy" means electrical energy.

The expression "generator" means the dynamo or dynamos, or other electrical apparatus used for the generation of energy.

The expression "motor" means any electric motor carried on a car and used for the conversion of energy.

The expression "pipe" means any gas or water pipe, or other metallic pipe structure or substance.

The expression "wire" means any wire or apparatus used for telegraphic, telephonic, electrical signalling, or other similar purposes.

The expression "current" means an electric current exceeding $\frac{1}{1000}$th part of 1 ampère.

The expression "the company" has the same meaning as in the ——— Tramways Act.

Regulations.

1. Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a steady continuous current.*

2. One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated throughout its length, and is hereinafter referred to as the "line"; the other may be insulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is hereinafter referred to as the "return."

3. Where any rails on which cars run or any conductors laid between such rails form any part of a return, such part may be uninsulated. All other returns or parts of a return shall be insulated.

4. When any uninsulated conductor laid between the rails forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100 feet, by means of copper strips, having a sectional area of at least $\frac{1}{10}$th of a square inch, or by other means of equal conductivity.

5. When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections, which shall be placed not less than 20 yards apart.

Provided that in place of such two earth connections the company may make one connection to a main for water supply of not less than 4 inches internal diameter, with the consent of the owner thereof.

Such earth connections shall be constructed, laid and maintained, so as to secure contact with the general mass of earth, and so that an electromotive force, not exceeding 4 volts, shall suffice to produce a current of at least 2 ampères from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with.

Where any portion of either earth connection is placed within 6 feet of any pipe, and the company are unable to obtain permission to metallically connect it with the earth connection, they shall provide, by means of a non-conducting screen, that no current can pass between the pipe and the earth connection, without traversing at least 6 feet of earth.

6. When the return is partly or entirely uninsulated, the company shall, in the construction and maintenance of the tramway, (*a*) separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) connect together the several lengths of the rails; (*c*) adopt means for reducing the difference produced by the current between the potential of the uninsulated return at any one point, and the potential of the uninsulated return at any other point, and (*d*) maintain the efficiency of the earth connections specified in the preceding regulations, so as to fulfil the following conditions, viz.:—

(i.) That the current passing from the earth connections to the generator shall not at any time exceed 10 ampères.

(ii.) That if at any time and at any place a test be made by connecting a galvanometer or other current-indicator to the uninsulated return, and to any pipe in the vicinity, the direction of the current, if any, shall be from the return to the pipe, and not *vice versa*.

(iii.) That under the conditions specified in (ii), it shall always be possible to reverse the direction of the current by interposing a battery of three Leclanché cells connected in series.

In order to provide a continuous indication that the condition (i) is complied with, the company shall place in a conspicuous position a suitable, properly connected, and correctly marked, current-indicator, and shall keep it connected during the whole time that the line is charged.

The owner of any pipe, may require the company to permit him to ascertain by test that the conditions (ii) and (iii) are complied with as regards his pipe.

7. When the return is partly or entirely uninsulated its electrical resistance shall be tested by the company at least once in every three months. If at any such testing it appears that the resistance has increased by more than 15 per cent. above the value recorded at the time the tramway was opened, the company shall take immediate steps to reduce the resistance to the said recorded value.

8. Every electrical connection with any pipe shall be so arranged as to admit of easy inspection, and shall be tested by the company at least once in every three months.

9. Every line and every insulated return, or part of a return, shall be constructed in sections not exceeding one half of a mile in length, and means shall be provided for isolating each such section for purposes of testing.

10. The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed $\frac{1}{100}$th of an ampère per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds $\frac{1}{10}$th of an ampère per mile of tramway, the running of the cars shall be stopped until the leak has been localised and removed.

* The Board of Trade will be prepared to consider the issue of regulations for the use of alternating currents for electrical traction on application.

11. The insulation resistance of all lines, insulated returns, feeders, or other conductors, laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of the insulation resistance of each part of the circuit shall be made at least once in each month.

12. Where in any case in any part of the tramway the line is erected overhead and the return is laid on or under the ground, and where any wires have been erected or laid before the construction of the tramway in the same or nearly the same direction as such part of the tramway, the company shall, if required so to do by the owners of such wires or any of them, permit such owners to insert and maintain in the company's line one or more induction coils or other apparatus for the purpose of preventing disturbance by electric induction.

13. Any insulated return shall be placed parallel to and at a distance not exceeding 3 feet from the line when the line and return are both erected overhead, or 18 inches when they are both laid underground.

14. In the disposition connections and working of feeders the company shall avoid injurious interference with any existing wires.

15. The company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively, and they shall not allow sparking to occur at the rubbing or rolling contacts in any part.

16. In working the cars the current shall be varied as required by means of a rheostat containing at least 20 sections, or by some other equally efficient method of gradually varying resistance.

17. In the construction and use of their generators and motors the company shall take all reasonable precautions to prevent the occurrence of undue sparking.

18. Where the line or return, or both are laid in a conduit, the following conditions shall be complied with in the construction and maintenance of such conduit:—

(*a*) The conduit shall be so constructed as to admit of easy inspection of, and access to, the conductors contained therein, and of all insulators and supports.

(*b*) It shall be so constructed as to be readily cleared of accumulation of dust or other *débris*, and no such accumulation shall be permitted to remain.

(*c*) It shall be laid to such falls, and so connected to sumps or other means of drainage, as to automatically clear itself of water without danger of the water at any time reaching the level of the conductors.

(*d*) If the conduit is formed of metal, all separate lengths shall be so jointed as to secure metallic continuity for the passage of electric currents, and where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or other means of equal conductivity, at distances apart not exceeding 100 feet. Where the return is wholly insulated and contained within the conduit, the latter shall be connected to earth at the generating station through a high resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit.

(*e*) If the conduit is formed of any non-metallic material, not being of high insulating quality and impervious to moisture throughout, and is placed within 6 feet of any pipe, a non-conducting screen shall be interposed between the conduit and the pipe, of such material and dimensions as shall provide that no current can pass between them without traversing at least 6 feet of earth.

19. The company shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.

Daily Records.

Number of cars running.
Maximum working current.
Maximum working pressure.
Maximum current from the earth connections (*vide* Regulation 6 (i)).
Leakage current (*vide* Regulation 10).

Monthly Records.

Condition of earth connections (*vide* Regulation 5).
Insulation resistance of different conductors (*vide* Regulation 11).

Quarterly Records.

Resistance of return (*vide* Regulation 7).
Conductance of joints to pipes (*vide* Regulation 8).

Occasional Records.

Any tests made under provisions of Regulation 6 (ii and iii).
Localisation and removal of leakage, stating time occupied.
Particulars of any abnormal occurrence affecting the electric working of the tramway.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AN ordinary general meeting of the Institution was held on Thursday evening, November 23rd, Mr. W. H. PREECE, F.R.S., President, in the chair.

The ordinary general business having been transacted,

The PRESIDENT said it was with extreme regret he had to record the loss of one whom they all loved very much indeed—Mr. Anthony Reckenzaun. As an electrician they had held him in great respect, and listened with great attention to all the opinions he expressed, and they were all exceedingly sorry to lose from their midst one who had taken such an active part in their proceedings. He was sure he had the support of the whole of the members when he expressed, in the name of the Institution, their condolence with the widow and family of Mr. Reckenzaun in the great disaster which had occurred to them.

Mr. GISBERT KAPP moved that a vote of condolence be officially communicated to Mrs. Reckenzaun, expressing their sympathy with her in the loss of her husband.

Prof. GEORGE FORBES seconded, and the resolution was carried.

The discussion was then commenced on Prof. George Forbes's paper on "The Electrical Transmission of Power from Niagara Falls."

Dr. FLEMING, in opening the discussion, said they must congratulate not only this Institution, but the Cataract Construction Company, upon having as their advisers engineers who were willing to take the enormous trouble which Prof. Forbes and his colleagues had taken in going round the world and examining carefully, deliberately, and thoroughly all that had been done in large schemes of power transmission before committing themselves to any system. It would have been a much easier thing to sit down and elaborate out of their own minds something exceedingly new and original, and probably, in the end, something very expensive; but they adopted the exceedingly wise and prudent course of thoroughly sifting all that had been done before committing themselves to important decisions. It would not do to take for granted that the effects of capacity on long lines could be neglected because they were not disagreeable apparent in short lines of a mile or two in length. They were exceedingly real, and capable of giving rise to very disagreeable and dangerous effects. The choice which Prof. Forbes had made for his type of line was evidently, as he had told them in the paper, very largely dictated by his desire to avoid those difficulties, and he had told them that one object in designing the lines for the transmission of power from Niagara to Buffalo was to so construct it that its capacity effects might be as far as possible reduced. One of the great risks which had to be avoided in the construction of these lines was the presence of pressure effects which occurred when the lines were suddenly connected to, or disconnected from, the machines—this ought never to be done in practice. Prof. Forbes was quite right in saying that under these circumstances surgings were set up in the cables and in the machines, and that pressure might become almost anything they pleased; it might become scores, if not many more times greater than the working pressure; in fact, it was impossible to say, under some circumstances, what the pressure actually did become, and under those circumstances it was of no use to say anything of failure of insulation, for no insulation would be sufficient to withstand the pressures that were brought against them. Fortunately, however, it was in their power to control those effects, and they were not all difficulties which could not be overcome. The methods by which they could be controlled had only to be known to be adopted in other cases where they were dealing with long lines which necessarily had some, and perhaps a good deal of, capacity, according to the type of cable which was used, and which were certain to have self-induction when connected with transformers at the other end. As Prof. Forbes had mentioned that those difficulties had been got over at Deptford, there could be no objection to his telling them the methods adopted by his colleague, Mr. Dalton, in consultation with himself and others. Those methods had been directed towards avoiding any change of pressure in the trunk mains which would arise from connecting or disconnecting from the omnibus bar of the machine. Every one who had tested it knew the risk of disconnecting condensers suddenly, and the same effects took place when concentric cables were connected or disconnected. An exceedingly vicious spark was seen, even when there was no load upon the other end. That, of course, was due to the capacity. The ordinary way of going to work was to connect suddenly by a quick switch; that was, of course, a disastrous way of doing it. The way in which it was done now was this: the cable was never suddenly connected, but a transformer was placed near the main, and that transformer had on its secondary circuit an arrangement by which it could be gradually short-circuited. Water resistance was generally employed, but it might be carbon resistance. Then there was an arrangement of three switches. A switch to close the inner member of the trunk main on to the omnibus bar, and on to the primary of the transformer, and on to the several circuits. The first process of connecting the trunk main was to keep the switch, B, open, and close A and C when the transformer was open-circuited on the secondary side. Under these circumstances the transformer offered a considerable impedance to the flow of current, and that nullified the capacity effect in the main. If there were this impedance, there was no sudden rush into the cable due to the capacity effect; it was under complete control. The next step was to gradually short-circuit the secondary circuit of the transformer, and to reduce the impedance of that transformer, getting rid of it little by little as slowly as possible. When completely short-circuited, and the switch closed, the current running into the cable, the capacity of the current was brought up from nothing to its full value as slowly and deliberately as they pleased. Then the transformer was disconnected, and connected on to the main. In *this* case exactly the reverse took place. The transformer was short-circuited on both its primary side and its secondary side, then the switch was opened, and the short-circuiting of the secondary was gradually removed. In that way the impedance was brought into the circuit gradually, and the current, as it were, stopped from running into the cable. When dealing with large cables the capacity might reach a very high point—one-third of a microfarad a mile. It was almost impossible to get a cable, if it was concentric, that had not a capacity effect. If they were to adopt a pressure of 20,000 volts, and a frequency of 100, which was probably what they would have done had they started this enterprise in England, and a capacity of one-third of a microfarad with 18 miles

of cable, the capacity of the current in that cable would have been 72 ampères, when nothing was connected at the other end. That could be easily calculated from the formulæ he gave some time ago. The capacity of the current to do work, or rather mischief, was proportional to the square of the current, and that square was proportional to the frequency, and thus the advantage of low frequencies, for the capacity was something enormous when they came to long lines. Anyone with experience would hesitate to adopt that unless accompanied by a large provision of this kind for controlling the flow into and out of the cable. These effects, then, were all increased by increasing the frequency. Hence the argument for reducing this frequency in any case in which it was possible to do so; and the same held good, the same effects were produced, in a certain degree, when machines were connected and disconnected suddenly with the omnibus bars, and he thought there was great safety in using artificial load in putting machines into and out of parallel. In all continental stations they did use this artificial load, and although that might be a necessity where they were dealing with machines which had considerable self-induction in the armature circuit and therefore larger drop. It was not such a necessity when dealing with machines of small self-induction and therefore small drop; nevertheless there was a great advantage in so doing. When he (Dr. Fleming) was at Rome last Easter he spent a long day with Prof. Mengarini at Tivoli, and the latter allowed him to experiment with the machines there as much as he pleased. They had an artificial load which took up 300 H.P., and this artificial load was made to resemble as closely as possible the real external line. The process of putting the machines in was this: first of all they put them on to the artificial line, and adjusted the incoming machines so as to give exactly the same current and volts on the same circuit as the current going out to Rome, 25 ampères at 5,000 volts on one machine. They then put on two machines and divided the current without any difficulty, then a third was put into parallel, and then a fourth and a fifth, each one giving absolutely five ampères. They were taken out, one by one, by reversing the process. That artificial line was used on all the Ganz stations, and he thought Prof. Forbes was very wise in making provision for it in dealing with his machines. It was curious that we had not adopted it much in England; he did not know any place where it was used in this country; yet at the same time he hardly knew any large alternating station on the Continent where it was not done. In the next place he would say one word on the question of pressure. He was very glaid to hear Prof. Forbes say he never intended the primary circuit to be opened. But the question naturally occurred, would not the primary circuit sometimes open itself? In other words, what was going to be done in the way of main fuses? That was really a serious question in dealing with these pressures. What kind of main fuses did Prof. Forbes intend to adopt? In his paper he mentioned a transformer, the secondary of which had a working arrangement which would gradually introduce impedance if the current rose above a certain value. He trusted that that arrangement would be found to work well, but at the present moment one great want in connection with large distributions of alternating currents was an arrangement of main fuses which would not interrupt the circuit, but, if the main current went above a certain value it would put impedance into the circuit gradually but quickly, and then take it out again as required, but never allowing the main circuit to be broken. The great difficulty at present was that it did become broken, and a great rise of pressure took place with disastrous results to the insulation. The insulation was strained or injured, if not broken down, and sometime afterwards a failure did occur. The question of pressure was one to which Prof. Forbes and his colleagues had doubtless given very serious consideration before deciding to adopt 20,000 volts. He was told by Prof. Mengarini and Mr. Blathy, at Rome, that they gave that question careful consideration before starting at Tivoli, and they could not see their way above 5,000 volts. They worked those machines quite successfully over 18 miles from Tivoli to Rome at a pressure of 5,000 volts, and they discussed this question very carefully in the light of all they had been able to learn at that time. The difficulty which might be encountered with this high pressure, was not the difficulty of working with the stock pressure of 20,000 volts, but the tremendous arcs which might be produced if they were started between the conductors. Prof. Forbes did not tell them, he believed, how far apart those cables were going to be in the conduits. He described a conduit in which copper strips were to be used as conductors, but did not mention what distance they were to be apart. That was a very important matter. It might be impossible under some circumstances to prevent such rises of pressure that an arc would start, and what would be the state of affairs in naked conductors in those conduits if only, say, a foot apart? Then one word upon the subject of frequency. The question was sometimes asked, what is the best frequency to work at? It was very much like asking, what is the best speed to walk at? It depended upon where you where going, and what you wanted to do. It must be determined by the various conditions under which they had to work. Continental engineers had not been at work at the matter at haphazard when they adopted a frequency of between 40 and 50. Our adoption of 80 to 100 was necessitated by the circumstances under which we had to start alternate current working, and the same in America. But there was no doubt, he thought, about the wisdom of selecting this low frequency at Niagara, where the utilisation of power by motors was an important matter, and there were enormous advantages to be gained by the reduction of these capacity effects and other effects of the same kind by the employment of a reduced pressure.

(To be continued.)

Stirling and Electric Lighting.—The Town Council have decided to consider in private a report by the Provost's Committee in reference to electic lighting.

CORRESPONDENCE.

Electric Light Mains.

I regret that the writer of your leading article on "Electric Light Mains" this week has not put himself more carefully in possession of the facts before he wrote. Without entering into any discussion whatever as to the most advisable system of mains to use, will you allow me to say that, as a matter of fact, the explosion in Glasgow—which, happily, was not a serious one—was due to the short-circuiting of an insulated treble potential lead, carried in a cast-iron pipe. It had nothing whatever to do with the use of copper strip, and, as a matter of fact, the copper strip in the adjoining troughs was not even connected up to the mains at all!

The statement that the electricity supply mains in Glasgow "have already shown very serious defects" is absolutely untrue.

Alex. B. W. Kennedy.

Your leader under the above heading is a direct challenge to all firms who have carried out extensive main laying operations to give to the technical public the benefit of the experience they have obtained. You blame us collectively for not having sufficiently ventilated this subject. I believe that one reason why papers stating the results obtained from various systems have not been offered to the Institution of Electrical Engineers has been that we have all been waiting for someone to read such a paper whose utterances would be considered as authoritative, and would be thoroughly impartial. Speaking for my own firm, we should welcome such a paper, as it would give us the opportunity we desire of letting everyone know how thoroughly successful our system of bare copper conductors has been, from whatever point of view it may be regarded. The system with which my own name has been connected has been now continuously in use for seven years without any accident of any description having occurred. During this time about 70 miles of streets have been provided with mains, strictly on our system, and constructed by ourselves; nearly one-half of this being in London, for the Kensington and Knightsbridge, the Notting Hill, and the Westminster Electric Supply Companies.

It is a very easy matter for us to prove beyond dispute that the 30 miles of mains laid on our system in the London district are now actually in just as good order as when first laid down, and that during the long period that they have been in use, extending in some cases to seven years, they have cost less for testing, inspection and maintenance than any other system that has yet been tried, and that there has been no accident of any kind with our mains, although they have been subjected to the severe test of inrushes of water into the culverts from the bursting of reservoirs, fire plugs and water mains, over which the supply companies owning the culverts have necessarily no means of control.

Turning to your article, I think you are incorrect in several of the conclusions to which you have arrived. There is not a particle of evidence to connect anyone of the explosions that have occurred, either in this country or on the Continent, with the gases furnished by the electrolysis of water; whereas, in most cases, there has been positive evidence that such explosions have been due to the infiltration of lighting gas leaking from the gas company's mains.

Also, you are incorrect in stating that these have occurred more frequently with bare copper systems in culverts than with other systems. I think if you tabulate the whole of the evidence that is obtainable on these explosions you will find that they have invariably occurred at junction boxes, and the majority have been at the junction boxes of a continuously insulated system.

I, however, thoroughly agree with you in one thing, that is the necessity of making completely water and gas-tight the culverts, pipes, or casings in which bare copper is laid on insulators, or into which insulator cables are drawn. If infiltration of water takes place, it is most probable that infiltration of gas will also take place, and it is solely due to the explosive mixtures finding their way into the surface boxes that the accidents hitherto recorded have taken place. We attribute the immunity that our system has enjoyed to our extreme care on this point.

As it is not likely that during the present session of the

Institution any paper will be read to ventilate this subject, I should suggest that you yourself should undertake this very interesting task, and, on behalf of my own firm, I promise to give you every possible assistance that lies in our power, that is to say, we will obtain permission for your representative to make examinations of such parts of the existing mains as he considers will best exemplify their advantages, or what he believes to be their disadvantages, and we will put him in the way of obtaining for himself the actual cost of inspection and maintenance, and of making house connections on to these mains. In the case of one complete system which is more directly under our control, namely that at Hove, we will allow him to make any insulation tests that he may desire.

An investigation of this kind has been undertaken during the current year by the authorities of Antwerp to ascertain which was the best system of mains that they could use for that city. It was only after the contract was awarded to us that we were informed how searching had been the enquiry, that letters had been written to and favourable replies received from every user of our bare copper system, and it was on account of the highly favourable nature of these replies that the contract was awarded to us, a distinction which has been awarded to no other English firm of contractors who have been competing for such work on the Continent of Europe.

R. E. Crompton.

November 27th, 1893.

Campiche's Electric Regulator Clock.

Referring to Campiche's pendulum described in your issue of October 20th, may I beg some further description of one or two points I do not understand.

The circuit being completed when the pendulum is at its right hand limit, it appears to me that the armature will have moved up to the magnet long before the pendulum has returned far enough to the left to receive an impulse from the bent rod attached to the armature.

I also gather from the diagram that the pendulum strikes the bent arm at every swing to the left. Am I right in thinking so? Does not the arc of swing vary very much between the impulses, to the detriment of its timekeeping qualities.

To refer to a rather old number, viz., September 16th, 1882, I should say that the method of giving an impulse to a pendulum therein described, by means of a spring instead of directly from the electro-magnet, is more likely to ensure an accurate rate of swing.

If you have space to discuss these points, an old reader will be grateful.

Time Ball.

[The circuit is completed on the *return* swing of the pendulum to the *left*, not on the *recoil* to the *right* as you have taken the description to mean; if you read the latter again carefully, you will, we think, see that we have correctly described the action. The armature, D, and the bent arm fixed to it are, as you suggest, struck each time the pendulum makes its return swing, but this action is so gentle and uniform that we understand that the timekeeping qualities of the pendulum (which has a heavy bob) are practically not affected by it.

Spellier's electric clock is undoubtedly an admirably well designed arrangement, and seems well adapted for good time keeping, but that of Campiche is stated to work satisfactorily, though we cannot speak from practical experience of the same.—EDS. ELEC. REV.]

Ingleton and Electric Lighting.—At a meeting of ratepayers held on November 16th, to consider the question of the introduction of electric light in the village, Mr. T. Preece, of Messrs. Andrews & Preece, Limited, addressed the meeting. We are informed that the reporters of the local paper made several errors in their report. They have stated that it was Mr. W. H. Preece who addressed the meeting, and amongst other mistakes they also stated that the electric light had already been introduced at Yeadon, which is not the case.

NOTES.

Electric Tramways in France.—The Roubaix-Tourcoing Tramway Company has asked for a concession from the Municipal Council of Mouveaux, Nord, for the construction of an electric tramway on the overhead trolley system. The proposal has been met favourably, but the Municipality declines all responsibility for any accidents which may result.

M. Levèque has asked the Grasse Municipality (Alpes Maritimes) for a concession, without subvention, for an electric tramway.

The town of Dijon has given the concession for its electric tramways to a Lyons cable manufacturer.

Electric Light Mains.—Following our leader of last week, we have heard that the promotors of bare wire or strip mains now propose to make the junction box covers something like safety valves. The lids are to be hinged, so that when the expected explosions occur the said lids will not be blown sky high, and possibly altogether lost; these lids will merely turn over on their hinges and let off the explosions. Whether this arrangement is an improvement so far as the safety of the public is concerned remains to be seen. The safety of the lid will at any rate be assured, and that is something to be proud of. The idea might be extended to the pavement; which probably could be hinged in the same way. We wonder what the engineer who adopted the explosive mains has to say on the matter.

Niagara Falls Electricity Works.—The discussion on Prof. Forbes's paper commenced on Thursday, and was taken up by Prof. Fleming, Messrs. Mordey, Swinburne and Kapp. A number of debatable points were raised, but as the discussion was not concluded we shall withhold our review of it in the meantime. Some of our contemporaries severely criticise the policy of "the group of men whom Prof. Forbes admiringly characterises as the most powerful combination of New York capitalists." The *Engineer* says plainly that "they have sucked the brains of European engineers in order to get their scientific work done cheaply." It has often been the case before, where a certain class of men do the real scientific work and another class come along and reap the rewards. Why is this thus? There is, perhaps, talent enough in America to carry through the whole job successfully, but Prof. Forbes's paper states clearly that there is a want of experience in parallel working of dynamos, in extra high pressures, and in low frequency, among American manufacturers, and we quite believe him.

Peculiarities of Alternating Arc Lamps.—*Industries*, referring to the paper on this subject published by us in our issue of 10th ult., while poking fun in a sarcastic style at the author of the paper, strongly insists upon the perfection and general good behaviour of arc lamps. That alternating arc lamps will work to perfection as regards perfect feeding, steady light, and efficiency, has been known for quite a number of years, perhaps 30 years at least. In fact all the early electric arc lamps for lighthouse purposes were alternating lamps, and are so still. It is nevertheless a fact that the continuous current arc throws more light just where it is most wanted in public lighting, that is, on the roadways. This can easily be recognised in London without taking a tour to Newcastle. A constant current alternating dynamo for arc lighting was brought out by the Westinghouse Company in America, and apparently such a machine was considered by them to be a great novelty. It seems that the historical education of these young American electricians in things electrical has been sadly neglected, both as regards alternating arc lamps and constant current dynamos. They don't seem to have heard of Gérard, Lontin, Chertemps, and Dauden, and many others who had made arc lamps and dynamos for alternating currents long before a Spencer or a Stanley were heard of. Chertemps and Dauden, in 1882, made a machine for constant alternating currents, which was tested and reported upon by Mr. Sabine. This machine acts quite as well, if not better, than the American one invented five or six years later, the current being perfectly constant and self-regulating, and is exactly on the same principle as Stanley's.

Cost of a Lecture.—Expenses paid to Messrs. Kincaid, Waller, and Manville, in connection with the lecture recently delivered by Mr. Manville, at Camberwell, amounted to £19 18s. 9d.

Royal Institution.—The annual course of Christmas Lectures will this year be delivered by Prof. Dewar. The subject will be "Air, Gaseous and Liquid," and the first lecture will take place on Thursday, December 28th.

Cable Interruptions.—The following is an account of the cable interruptions and repairs as issued by the International Bureau, of Berne, for the week ending November 29th:—Bissao-Bolana cable interrupted November 24th; Cayenne-Vizen cable interrupted November 25th; Jamaica-Colon cable interrupted November 25th.

Correction.—In our note on Woolwich electric lighting last week, an error occurred. The £4,000 mentioned was not for electric lighting purposes, but for sinking a well for supplying water to the new baths. The contract for the electric lighting has already been given over to the local electric supply company.

Poplar Electric Lighting.—The Poplar Board of Works has decided to invite Mr. W. H. Preece to report, at an expense not exceeding 50 guineas, upon the question of electric lighting and the application of the Poplar Electric Lighting Order, 1893, to the district, with particulars of the cost of the installation of the light.

An Electric Tower.—One of the features of the forthcoming California Midwinter Exposition, to be held at San Francisco, is an electric tower, the design of a Chicago architect, upon which work will be commenced at once. It will be 266 feet high, and throw out enough light to illuminate the entire valley. Over 8,000 incandescent lights of different colours will be used on the outside framework of the tower.

Central London Railway.—As we stated in our last issue, this company is applying to Parliament for extension and other powers. The wording of the application, as published in the *London Gazette*, certainly gave us the impression that it was the intention of the directors to adopt same motive power other than electricity. From a letter penned by the secretary, and published in the *Financial News*, we find we are in error. He states that it is not in contemplation to work the Central London Railway by any other motive power than electricity.

Institution of Electrical Engineers.—At a students' meeting to be held at the Library of the Institution of Electrical Engineers, a paper will be read to-night (December 1st), by Mr. Arnold Phillip, on "The Mechanical Testing of Electro-Deposited Films of Metal." We would like to offer a gentle hint to the honorary students' secretary, that the notices sent to ourselves, and apparently to others, are in the form of a letter, and are not passed by the postal authorities as circulars, as he evidently considers. Perhaps it will be in the interest of many people if he will give a thought to the matter when again sending out the notices.

New Cable.—News from Port Louis, dated November 25th, says:—"The new cable connecting Mauritius and the Seychelles with Zanzibar, and this with Europe, was inaugurated to-day by the Governor, Sir Herbert Jerningham. The ceremony, which evoked much enthusiasm among the inhabitants, was witnessed by a great concourse of spectators, a detachment of troops and sailors from H.M. cruiser, *Cossack*, being also present. On the receipt of a telegram from the Queen, in reply to a complimentary message sent to Her Majesty on the occasion, a royal salute was fired. A reception was afterwards held at Government House, at which Her Majesty's reply was read by the Governor, and was received with loud cheers."

The Eastern Telegraph Company announce the laying and opening for traffic of the Mauritius cable, thus connecting the Islands of the Seychelles and Mauritius with Zanzibar and this company's general system of submarine telegraphs. The through tariff to Mauritius from the United Kingdom will be 8s. 9d. per word.

Personal.—We are informed that Mr. James Swinburne has resigned the post of electrical editor of *Industries and Iron*: he, however, will remain a contributor to that journal.

We hear that Mr. Money-Kent has been elected managing director of the Kelvinside Electricity Company.

The Royal Society.—Yesterday was held the Anniversary Meeting for electing the Council and Officers for the ensuing year. On Thursday, December 7th, at 4.30 p.m., the following papers are to be read:—"A Dynamical Theory of the Electric and Luminiferous Medium," by J. Larmor, F.R.S.; "Note on the Action of Copper Sulphate and Sulphuric Acid," by Prof. Schuster, F.R.S.; "On Copper Electrolysis *in vacuo*," by W. Gannon.

Lectures.—At a meeting of the University College, Bristol, Engineering Society, held last week, a paper was read by Mr. E. Basil Wedmore on "The Manufacture of Incandescent Electric Lamps."

Before the Association of Scottish Colliery managers on Saturday, Mr. Robert Weir read a paper on "The Applications of Electricity to the Developments of Dip Workings and other purposes."

The fifth lecture of the Gilchrist series was given in Dover Town Hall last week by Dr. J. A. Fleming, professor of electrical engineering in University College, London, the title being "Magnets and Electric Currents."

The Starting of Railway Motors.—Mr. E. C. De Segundo, in an article in *Industries* on the Worby-Beaumont variable gear for tramcars and electric locomotives, which has been proposed as a remedy for the loss in starting, refers to Kapp's fly-wheel suggestion as if it were intended for the same purpose as the variable gear. This is not the case; the fly-wheels are to be introduced at the generators to regulate the large fluctuations of current in the mains, and can in no way mitigate the losses in the car motors. Hopkinson's plan (so-called) was really first tried by the late Mr. Reckenzaun with some success. The electrical way of starting is stated to be yet unknown. We believe the proper way is quite well known, although it is not in use. The loss is not so much in the large current at the start as in the resistances introduced to keep the current down to a safe value.

Old Students' Association.—The annual report for the eighth session (1892-93) states that the Association has sustained great losses during the session in the deaths of Mr. Herbert C. Saunders, Q.C. (an honorary member), and of Mr. Anthony Reckenzaun (a most valued member of the committee), both of whom took great interest in the Association. The committee regret the resignation of Mr. E. B. Vignoles from the secretaryship. While congratulating the Association on the very successful session which has now terminated, the committee are of opinion that, in order to attain a still larger measure of success, the Association should be so developed that its operations do not conflict with those of other bodies. There are equally successful societies for the purpose of reading scientific papers, and it therefore seems to us that, in the future, greater prominence should be given to the social aspects of our work—a department which has always formed the strongest bond of union between our members. For this reason your committee have deferred the election of the new officers till such time as they could submit to a general meeting the following suggestions for the future working of the Association:—1. That for the future the Association should be worked on more distinctly social lines; and that for this purpose meetings for the reading of scientific papers should only be held when matter arises of sufficient importance. 2. That three regular meetings, viz., a dinner, a *conversazione*, and a smoking concert be held in each session. 3. That the subscription be made a nominal one, for the purpose of defraying clerical and other incidental expenses in connection with the work.

A general meeting is to be held on Tuesday next (December 5th), to receive the annual report and balance-sheet, and to consider the scheme proposed for the future working of the O.S.A. Mr. Ll. B. Atkinson, the retiring president, will give an address, entitled, "A Trip to Chicago," relating his impressions of America.

The Electric Light in Belfast.—On Saturday last Queen's Quay was illuminated for the first time with the electric light.

The Institution of Electrical Engineers.—On Thursday, December 14th, 1893, the annual general meeting will be held, for the reception of the annual report of the council, and the election of council and officers for the year 1894. The discussion will be continued on "The Electrical Transmission of Power from the Niagara Falls," by Prof. George Forbes, F.R.S.

Harrow and Electric Lighting.—The Local Board have decided to apply for a provisional order. They have already a suitable site for a station if such is eventually erected.

Mattei's Liquid Electricities.—The correspondent who wrote to us concerning these remedies some weeks ago, and whose letter we published in our issue for October 29th, has sent us the following further communication :—"You were good enough to give publicity to a letter I sent you about two months ago on the subject of Count Mattei's remedies, but, unfortunately, it has called forth no reply from Mr. Gliddon. We are, therefore, still unacquainted with the proofs, based on 'recent advances in electrical science,' which were to show the manner in which the remedies 'partake' of electricity. I have lately heard from the lady mentioned in my former letter to the effect that she had heard from Mr. Gliddon, and that he had mentioned that he had no time to deal with the matter at present. It is some satisfaction to have heard this, since we may still live in the hope that in due time the proofs may be forthcoming. It is to be sincerely hoped that the true reason for the long silence is in no way due to a fear lest, through a fuller revelation of the Mattei medicines in a scientific journal, the system should receive a share of the public spleen which Mr. Harness, and his methods, is now coming in for. I have just been reading an article on Mr. Stead's proposed 'Daily Paper,' contained in the Christmas number of the *Review of Reviews*, on the system under consideration, and in it occurs the following question and answer :—Mr. Stead : 'But why does the Count not give up his secret to the world ?' Mr. Gliddon : 'That is a long story. Each of us must act according to his own lights, and the Count believes that he can best secure the purity of the medicines, and therefore the efficacy of the remedies, by keeping it in his own hands, and placing it on the market at as low a rate as it can profitably be manufactured.' The dialogue proceeds to affirm that the system is *not* being carried on for gain, and that such profits as do accrue will be devoted to 'public purposes.' But whatever may be the motives and purposes for which it is carried on, the above reason for keeping it secret is not very convincing or satisfactory to *every* one. The usual, if not invariable, result, of the dissemination of knowledge of any kind, whether it relates to an industrial process, the treatment of a disease, the study of natural phenomena, &c., is greatly to enhance its importance and value. All our scientific societies and literature are based upon the application of this most obvious and fundamental principle, and it is one which, from its very familiarity, would seem to be wholly unnecessary to defend. The originator and inventor of anything has usually the advantage in utilising and developing the outcome of his brain, but others are also capable of adding something, and, in process of time, of far outstripping him in the development. For commercial purposes trade secrets are, perhaps, legitimate ; though, even here, it is an open question whether the community would not be greatly benefited if there were none. But where, as in the present instance, the secret is kept from no money-seeking inducement, and where only the good of mankind is professed, it becomes very mysterious why secrecy should be maintained. The Count is, of course, justified in doing what he conscientiously believes to be right, but it would be much more satisfactory if he would give some convincing reason for his belief that in this case the general, if not universal, rule attending the dissemination of knowledge should be set at nought."

Electric Lighting in Paris.—In Paris, proposals seem to fall on deaf ears. Three or four times have the Municipal Council been asked to light by electricity the Square of the Tour St. Jacques. Nothing, however, has as yet been done or even discussed with regard to this subject. M. Opportun, the Municipal Councillor for this quarter, has just repeated the proposal.

Electric Illuminations in Paris.—During the Franco-Russian fêtes which took place in October, a series of electric illuminations took place in Paris. We will mention specially the illuminations in the Place de l'Opéra. Six poles were put up from which lines of incandescence lamps were suspended. The electrical energy was supplied by temporary derivations from the Edison Company's system, which passes through the neighbourhood. Electric search-lights threw their rays over the Place de l'Opéra and the military circle. There were two in the Place de l'Opéra and one in the military circle. The object of these illuminations was to show the public that there is no limit to the applications of electrical energy. It seems there has been an appreciable increase in the consumption of electrical energy since the illuminations took place.

Société Internationale des Electriciens.—The re-opening of the Société Internationale des Electriciens took place on November 8th. As at most reopenings, there was a numerous attendance. M. Hillairet, general secretary, spoke of the work that had been submitted to the Society. The president, M. Raymond, in proposing some new members for election, referred to the deaths of M. Mariè Davy and M. Achard, which had occurred during the vacation. M. Mascart then gave a sketch of his visit to America. He illustrated his narrative by a number of views, the photographs of which were taken with the Jumelle-Carpentier apparatus. He reminded his audience that the Americans have adopted the *Henry*, instead of the *Quadrant*, as the practical unit of the coefficient of self-induction. He referred to the continuous current dynamo of 1,500 kilowatts, and mentioned 500 H.P. as the current power of dynamos in America.

The Electrical Sector of the Left Bank, Paris.—The electrical sector of the left bank is certainly in strange hands. On the occasion of the Russian fêtes in October last, there was a temporary illumination in the Rue Soufflot and the Place du Panthéon by means of 30 Eck arc lamps, suspended to posts erected for the occasion. The electrical energy was supplied from an old station established five years ago on the Place du Panthéon. Soon after we received *Le Journal* for October 26th, which announced that the station of the left bank sector had been visited by some of the municipal councillors for the inauguration. We find, however in *La Ville* for October 4th, a note which may throw a clearer light on the proceedings of this sector, and which runs as follows :—"*The Sector of the Left Bank.*—The engineer to whom the sector of the left bank has been entrusted, invited the municipal councillors to attend the opening of his works. Very few, however, availed themselves of the invitation, for they knew that the inauguration would be of little interest. In fact, M. Naze has simply had the machines of the Oerlikon Company, which had been abandoned five years ago, put in order, which has not required great efforts on his part." The curious part of the story is that the works in question were closed by the Administration, for they openly violated an article in the specification forbidding any foreign plants to be used in the working of the sectors. Thus we find a director of a sector who can think of no better plan of proceeding than to re-open works containing not a single French machine, and who then has the audacity to invite the Municipal Council to attend their inauguration. We hope the council will put a stop to M. Naze's proceedings, and show him that the specification applies to all. Moreover, fresh difficulties are before him, and up to the present he has done nothing but show proofs of incompetence. The fate of the sector of the left bank cannot long be allowed to remain in such incompetent hands, and the council will no doubt soon call upon him to resign in favour of a successor who will devote more serious attention to his trust.

NEW COMPANY REGISTERED.

Ander's Telephone Company, Limited (39,906).—This company was registered on the 13th ult. with a capital of £10,000, in £1 shares, to acquire certain English patents granted for the improvements of telephones, and to carry on business as manufacturers of and dealers in all kinds of telegraphic, telephonic, and electric apparatus. The subscribers (with one share each) are:—M. F. Barthelmers, Fenchurch Street, E.C., clerk; J. Limberger, 83, Underhill Road, S.E., merchant,; G. Francke, Camden Road, merchant; W. Seward, Wandsworth, merchant; W. Heyneman, 50, Beresford Road, N., merchant; R. W. Hutchinson, Millwall, gentleman; R. H. W. Rind, Ferndale, Shortlands, merchant. Registered, without articles of association, by Messrs. Goldberg, Langdon & Co., 1, West Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Electric Tramways and General Syndicate, Limited.—The last return of this company shows that out of a nominal capital of £10,000, in 1,850 "A," and 150 founders' shares of £5 each, 7 "A" and 87 founders' shares have been taken up. Nothing has been called on the "A" shares, but the full amount has been called up on the 87 founders' shares. There has been £435 paid.

London and Hampstead Battery Company, Limited.—The last annual return of this company shows that out of a nominal capital of £50,000, in 7,000 preference and 3,000 deferred shares, all of £5 each, that 615 of the former, and the whole of the latter, have been taken up. Sums of £5 and £3 10s. have been called on each of 249 and 366 shares, respectively. The total amount of calls equals £2,170; £15,000 has been considered as paid, and £356 is still outstanding.

National Telephone Company, Limited.—The last annual return of this undertaking shows that, out of a capital of £4,000,000, in 15,000 first preference shares of £10 each, 15,000 second preference shares of £10 each, 250,000 third preference shares of £5 each, and 490,000 ordinary shares of £5 each, the whole of the first and second preference, 119,234 of the third preference, and 484,597 of the ordinary shares have been taken up. The full amounts have been called on all these shares, and £3,002,595 has been received. A sum of £316,560 has been agreed to be considered as paid.

Scarborough Electric Supply Company, Limited.—The statutory return of this company shows that out of a capital of £50,000, in £10 shares, that 1,980 shares have been taken up, with £4 paid on each. There has been £7,922 remitted, and £8 is outstanding.

Printing Telegraph and Construction Company of the Agence Havas, Limited.—The statutory return of this company shows that out of a capital of £115,000, in £5 shares, that 23,000 shares have been taken up. A sum of £2 has been called on 12,177 shares, and £5,400 10s. has been received. The amount agreed to be considered as paid on 10,823 shares is £54,115, and there is £18,953 10s. in arrear.

Taylor and Tucker Art Metal Company, Limited.—The nominal capital of this company was £5,000 in £1 shares; and the last annual return filed at Somerset House shows that 4,400 have been called up. The full amount has been paid.

Allen Everitt & Sons, Limited.—The 1893 return of this concern shows that out of a nominal capital of £300,000 in 10,000 preference, and 20,000 ordinary shares of £10 each, the whole of the preference and 12,000 ordinary shares have been taken up, with £10 paid on the former, and £8 on each of the latter. The sum received is £131,000; and £65,000 has been agreed to be considered as paid.

Blockley Electric Lighting and Manufacturing Company, Limited.—This company filed its annual return on the 10th inst. It shows that the nominal capital is £20,000 in £5 shares, and that out of this 461 ordinary and 72 preference shares have been taken up, with the full amount paid on each. The total amount remitted is £2,665.

Bournemouth and District Electric Supply Company, Limited.—This company has filed its yearly return. This shows the original capital to be £50,000 in £5 shares, out of which 5,725 shares have been taken up and fully paid.

Brighton and Hove Electric Light Company, Limited.—This company filed its yearly return on the 2nd inst., which shows that out of a nominal capital of £100,000 in £5 shares, 3,001 shares have been taken up, with the full amount paid on each. The amount received reaches £15,005.

Buenos Ayres Electric Light Company, Limited.—The annual return of this company has been filed, which reveals the fact that out of a nominal capital of £100,000, in 9,986 £10 and 70 £2 founders' shares, the 70 founders' only have been taken up. Nothing has been paid.

Abell's Electrical Engineering Company, Limited.—A short time ago it was decided that this company should be wound up under the provisions of the Companies' Acts, 1862 and 1867, and Mr. F. W. Marsh, of Liverpool and St. Helens, was appointed liquidator.

Chelsea Electricity Supply Company, Limited.—The 1893 return of this company shows that out of a nominal capital of £100,500 in 14,000 £5 ordinary, 6,000 £5 preference and 500 £1 founders' shares; 9,277 ordinary and the whole of the founders' shares have been taken up. A sum of £5 has been called on each of 3,611 shares; £18,055 has been remitted; and £28,330 has been agreed to be considered as paid on 5,666 ordinary and the founders' shares.

Column Printing Telegraph Company, Limited.—This company has been dissolved under Clause 7 (4) of the Company's Act, 1880 (43 Vict., Ch. 19), by notice in the *London Gazette*, dated August 15th, 1893.

Miners' Lamp Electric Lighting Company, Limited.—This company's yearly return shows that 301 shares have been taken up out of a nominal capital of £3,000 in 600 £5 shares. The full amount has been called; £555 has been paid; £950 has been agreed to be considered as paid, and £5 is still outstanding.

British Electric Propulsion and Traction Company, Limited.—The registered office of this company, which was formerly at 50, Gresham Street, E.C., has been changed to Victor Works, Victor Road, Holloway, N.

Barry and Cardiff Electric Light and Power Supply Company, Limited.—From a document lately filed at Somerset House, we learn that this company was dissolved under clause 7 (4) of the Companies' Act, 1880 (43 Vict., Cap. 19), by notice in the *London Gazette*, dated August 15th, 1893.

Bernstein Electric Lamp Company, Limited.—The last annual return of this company, just filed at Somerset House, shows that out of a capital of £100,000, in £10 shares, 2,814 shares have been taken up, with the full amount called on each. There has been £28,140 paid.

Aurora Electric Lighting and Distribution Company, Limited.—This company's annual return, filed on October 17th last, shows that out of a capital of £25,000 in £1 shares, 5,935 shares of £1 each have been taken up. A sum of £935 has been paid, and £5,000 has been agreed to be considered as paid.

Brompton Electric Fittings Company, Limited.—This company filed its yearly return on October 17th last, which shows that out of a nominal capital of £2,000 in £1 shares, 1,050 shares have been taken up. The full amount has been called and paid.

Norwich Electricity Company, Limited.—From the latest annual return of this company we learn that out of a nominal capital of £50,000, in £10 shares, 1,774 shares have been taken up; £8 has been called on each share, and the total amount received is £14,226 10s., *including* the *full* sum paid up on 36 shares. There is £37 10s. outstanding.

Madras Electric Tramways Company, Limited.—This company's annual return, filed on October 31st, shows that out of a nominal capital of £100,000 in £1 shares (or Rs. 15); 78,792 shares have been taken up. A sum of 10s. has been called on 14,427 of these and 9s. 4d. (or Rs. 7) on 44,715. The total amount received is £19,544 19s. 8d.; £19,650 has been agreed to be considered as paid; and £8,535 10s. 4d. is in arrears.

Merveilleuse Electric Arc Lamp Syndicate, Limited.—According to the statutory return of this company it appears that out of a nominal capital of £15,000 in £1 shares, only the seven signatories' shares have been taken up and fully paid.

Midland Electric Light and Power Company, Limited.—This company has filed its annual return. The nominal capital is £50,000 in £10 shares, and 3,139 shares have been taken up; 3,132 have been issued as fully paid and the full amount has been called and paid on the remaining shares.

Otis Elevator Company, Limited. — This company's statutory return shows that out of a nominal capital of £50,000, in £10 shares, 2,000 shares have been taken up, and that £4 has been called on each of 1,350 shares. The total sum paid is £8,100; and £6,500 has been agreed to be considered as paid.

Association for the Protection of Telephone Subscribers, Limited.—The registered office of this company is now at 58, Coleman Street, E.C.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—December 15th. For the following works in connection with their electric lighting station in Chapel Lane, Belfast, for the Corporation of Belfast. Contract 1. Gas engines and dynamos. 2. Switchboard and connections. 3. Batteries. 4. Laying of concrete culverts. 5. Cast-iron work. 6. Insulators. 7. Insulated cable. 8. Copper strip. Copies of any of the specifications can be obtained from Sir Samuel Black, town clerk, or from Prof. A. B. W. Kennedy, consulting electrical engineer to the Corporation, 19, Little Queen Street, Westminster, S.W.

Ealing. — December 6th. For the building of the engine and boiler house, &c., and accessories at the central station, situated at the extreme south of the district, for the Ealing Local Board. Plans may be seen on application to Messrs. Bramwell and Harris, engineers, 5, Great George Street, Westminster, S.W.

Greenock.—For fitting a wooden steam yacht of 60 tons with electric light, as follows: 20 incandescent lamps about cabins and saloons of 4 C.P. each, two masthead lamps of 210 C.P. each, with wires; dynamo and engine of sufficient power to run all lamps at same time. Tenders will also be considered for a second-hand complete apparatus. Apply to Messrs. J. & H. M. Paterson, naval architects, &c., 32, Eldon Street, Greenock.

St. Pancras.—December 8th. Tenders for excavating and constructing an underground water tank in connection with the electric lighting and refuse destructor station in King's Road, Camden Town, N.W. Further particulars will be found among our advertisements.

CLOSED.

Halifax.—The Gasworks Committee have accepted tenders for the works in connection with the electric light installation in Halifax. The engines are to be supplied by Messrs. Pollit & Wigzell, Sowerby Bridge; Messrs. Yates & Thorn, Blackburn, will supply the boilers; and Messrs. Siemens Bros. & Co., London, the mains. We believe the Cripplegate site will be recommended for the lighting station.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's), now under the direct supervision of the proprietors, H. Alabaster, Gatehouse & Co., is in active preparation for the 1894 edition (13th year). This is a directory of the electrical trades embracing the whole Universe, and having no superfluous matter irrelevant to a directory it can be sent everywhere, carriage paid, for 4s. It is indispensable to all having business transactions in the electrical world, and once used cannot be done without. Advertise in it! Order it! It will prove the best outlay ever made.

The Electric Light in Derry.—The extensive project undertaken by the Corporation for the street illumination of Derry by electric light is nearing completion. It is understood that, unless some unforeseen circumstance occurs, the promoters are confident that the greater portion of the city will be electrically lighted before Christmas. The new generating station will shortly be finished. One engine has already been put in position, and the makers state that in less than a fortnight they will be able to test it under steam. This engine is of the compound marine type, capable of working up to 140 horse-power. The fly-wheel is 8 feet in diameter. Only one-third of the area of the yard at the station is occupied by the buildings for the street lighting, the remainder being reserved for the house-to-house lighting scheme should the citizens express a desire to take it up. A feature of considerable convenience in respect to the practical work of the station is that coals can be run into it direct from the quay. The condenser and other underground pipes are carried in chambers built under the floor, so that access can be had to them at all times. The generating room is 60 feet long by 40 feet wide. The roof is of a substantial description, carried on six massive pine girders of goodly proportions, spaces at every 10 feet apart. The underside of the rafters is sheeted with tongued and grooved boards, presenting a very finished appearance. Thirteen feet above floor level runs an overhead travelling crane for lifting any part of the machinery. The boiler-house is built to contain two Lancashire boilers, with cross Galloway tubes, each 26 feet long and 7 feet in diameter, and each capable of generating steam for 200 horse-power with average coal and draught. At the back of the boiler is fixed a Green's patent fuel economiser, consisting of 96 pipes. A local reporter says that the fine chimney stack speaks for itself. It is 125 feet high, measured from the ground level, being one of the tallest, if not the tallest, chimney stack in the city. The flue is throughout 5 feet in diameter, and lined with fire-brick for a height of 20 feet up from the bottom, and for 5 feet at the top. The dynamos are ready for delivery, but it is not considered desirable to have them on the spot until the engine and flooring are complete. The switchboard is on the ground and will be erected next week. The street cables are now completed in two circuits. There are in all 17 miles of cables already laid in the city and Waterside. Over 100 street pillars have been erected in the various thoroughfares of the city, and the lamp carriers, ready for the lamps, have been fixed on most of them. The carriers are still being erected at an average rate of eight per day, and the switches are also being fixed inside in each. A number of the lamps are already on the spot complete for erection upon the pillars. All the electrical work in connection with the scheme is being carried out by Messrs. Siemens. Bros. & Co., Limited, London, under the personal supervision of their engineer, Mr. W. A. Collings. The lamp pillars are being supplied and all mechanical work satisfactorily performed by Messrs. Alex. Brown & Son, Derry. The contract for the station buildings, chimney, boiler setting, foundations, &c., is in the hands of Messrs. Matthew M'Clelland & Co., whose work is being performed in a style worthy the reputation of the firm. The designs have been furnished by Mr. R. Eccles Buchanan, C.E., architect, Shipquay Street; while Mr. H. W. Blake watches the interests of the Corporation as their consulting engineer. The chairman of the City Lighting Committee, Councillor T. S. Magee, has been very energetic in introducing electric light, and he is mainly responsible for the advanced state of the work.

Provisional Orders.—Following on our list of last week, we observe notices in the *London Gazette* of the following applications which are to be made to Parliament and Board of Trade for provisional orders, &c:—

Harrow.—Application by the Urban Sanitary Authority for power to produce, store, and supply electricity within the urban district of Harrow.

Guildford.—Application by the Holloway Electricity Supply Company, Limited, for power to produce, store, and supply electricity within the borough.

Bristol Tramways.—Application by the Bristol Tramways and Carriage Company, Limited, for power to construct new tramways in and about Bristol; electrical, mechanical, or other motive power to be used.

Buxton.—Application by the Local Board for power to produce, store, and supply electricity within their district.

Liverpool, Bootle, and Walton-on-the-Hill Tramways.—Application by the Liverpool United Tramways and Omnibus Company for power to construct additional tramways in these districts; also permission to use electrical power thereon, and on previously authorised tramways.

Dudley and Wolverhampton Tramways.—Application by the Dudley and Wolverhampton Tramways, Limited, for power to construct tramways and work them by cable, electric, locomotive, or other power.

South Staffordshire Tramways.—Application by the South Staffordshire Tramways Company, Limited, for power to construct tramways and work them by cable, electric, or other motive power, except steam.

Yeadon.—Application by the Local Board for power to produce, store, and supply electricity within the district.

Charing Cross, Euston and Hampstead Railway.—Application by this company for power to purchase additional lands; also various incidental powers.

Croydon Tramways.—Application by the Croydon Tramways Company for power to construct tramways, and work them by cable, electrical, or other motive power, except steam.

Bedford.—Application by the Bedford Electric Light Company, Limited, for power to produce, store, and supply electricity within the borough of Bedford.

West Hartlepool.—Power to the corporation to produce electricity in the borough.

Moss Side.—Power to the Collier-Marr Telephone and Electric

Manufacturing Company to produce, &c., electricity in Moss Side sanitary district.

Birmingham.—Power to the Birmingham Electric Supply Company, Limited, to supply, &c., electricity within certain parts of Birmingham. Various incidental powers.

Liverpool Tramways.—Application by the corporation for power to extend their tramways, and to use steam, electrical, or other motive power.

Epstein Accumulators.—Messrs. Barclay & Son have carried out tests on this accumulator and the following is the report:—"In this series of tests, extending over the period of three months, two cells were used each containing 9 plates, five being negative and 4 positive. The cells when received showed a potential difference each of 2·2 volts per cell. They were discharged after standing three days at 40 ampères for four hours. The P.D. per cell had then fallen to 1·9 and they were re-charged till the P.D. was 2·35 per cell. The ampère hours expended in charging was 180. The cells were now discharged at 32 ampères for 5½ hours, the P.D. falling to 1·9 per cell, and charged to an equivalent of 187 ampère hours. This charging and re-charging was repeated several times at about the same rates, and upon taking the mean of the several experiments the following is the result: Charge, 190 ampère hours, 438 watt hours per cell; discharge, 180 ampère hours, 334 watt hours per cell; efficiency, 94·77 ampère hours per cent., 76·25 watt hours per cent. The cells were now discharged until the P.D. fell to ·6 volt per cell and allowed to stand 24 hours before re-charging. They were then charged up until the P.D. was 2·35 volts per cell, and upon discharging the loss of capacity was found to be only 10 ampère hours. This was repeated four times and the loss of capacity was 12 ampère hours at the 32 ampère rate of discharge. The cells were after this test charged and discharged for 10 days at the old rates of 190 and 180 ampère hours respectively, and the mean efficiency came out at: 94·1 ampère hours per cent., 76·05 watt hours per cent. The cells were now short-circuited until the voltmeter showed P.D. at the terminals = 0. They were again fully charged up and showed a capacity of 160 ampère hours at a rate of discharge = 30 ampères. The old rate of efficiency was again reached in eight days by charging and discharging within the limits already specified. I now tried a higher rate of charging and discharging, the former being taken at 50 ampères and the latter at 60 ampères. After several tests I found the mean capacity to be 145 ampère hours at this rate of discharge and the mean efficiency to be: 93·25 ampère hours per cent., 75·1 watt hours per cent. This completed the tests of the Epstein cells. During the whole time the cells were under observation, no particular care was taken of them and, in fact, they were frequently subjected to very rough treatment, being short-circuited once until no energy was left, and three times for a second, as it might be, accidentally. They were also left standing discharged for 168 hours, once for 72 hours, and frequently 8—12 hours. At the end of these tests no fault was apparent beyond a slight buckling of one of the end plates, and this was remedied and could have been prevented by wedging up. No signs of sulphating were at any time visible."

Sunderland Electric Lighting.—THE TENDERS.—At the meeting of the Corporation Highways Committee last week a sub-committee presented a report on the tenders which have been received from contractors to lay the necessary plant for the introduction of the electric light in the main streets of the town. There are eight different contracts tendered for as follows:—(1) For Lancashire boilers, 28 tenders; figures varying from £1,235 to £2,500. (2) Engines and dynamos, 16 tenders; figures from £4,640 to £6,015. (3) Motors and alternative switchboards, 15 tenders; figures from £1,100 to £3,000. (4) Main switchboard instruments and connections, 19 tenders; figures from £575 to £1,350. (5) Batteries, 7 tenders; figures from £763 to £2,260. (6) Installation couples, 7 tenders; total prices to be ascertained on measurement. (7) Road-work; prices to be ascertained on measurement. (8) Copper strip, 11 tenders; price from 5¾d. to 7¼d. per pound. One firm, Messrs. Parsons & Co., of Newcastle, tendered to do the whole of the work on a system of their own for £19,044. The consideration of the report was held over. Plans were submitted for the roofing of the buildings at the proposed electric lighting station, and the borough engineer was instructed to have the plans lithographed, and to take out quantities for the purpose of obtaining tenders.

Workshop Lighting.—Messrs. C. A. Parsons & Co., Heaton Works, Newcastle-on-Tyne, have just completed an electric light installation for the L. & Y. Waterproof Garment Company, Cornbrook. Mostly arc lamps are used for lighting the workrooms. These lamps are suspended from the ceiling, and are inverted. The light cannot be seen, as it is within a large reflector, which throws the rays of the light upon the whitewashed ceiling, which acts as a very large reflector, and distributes the light in a soft daylight manner, and thus prevents any possibility of getting a shadow at any part of the room. The limewash on the ceiling also has the effect of destroying the peculiar blue or violet colour usual in arc lamps, thus enabling any colour to be easily matched at night. Glow lamps are fitted in the offices and small rooms. A 19½ I.H.P. gas engine drives a 12-unit dynamo. The switchboard is designed to control the various circuits from the dynamo room. Messrs. Parsons are at present engaged in supplying and erecting over 60 inverted arc lamps for workshop lighting in various parts of the district. Messrs. Parsons's local agent, Mr. J. Moore, of Bolton, superintended the carrying out of the work.

Kensington and Electric Lighting.—In a recent issue we published the report of Major General Webber and others *re* electric lighting. The Vestry met to consider the proposals therein contained, and by a large majority rejected the report. A Mr. Braye has been braying in favour of the report, but with little effect. He considers the Ratepayers Association have been the means of keeping back electric lighting and threatens to resign his seat in consequence.

Bury and Electric Lighting.—The Bury borough surveyor has submitted his annual report. In his comments on electric lighting he says:—"Much time and labour have been expended in the consideration of this subject. It will be in your memory that the committee appointed last year to consider the question, acting upon the advice of Dr. John Hopkinson, F.R.S., recommended the corporation to retain the power of supply, and not to allow a company to obtain parliamentary powers for that purpose, and to adopt what is known as the low tension three-wire system; that upon this recommendation the council authorised an application to be made to borrow £20,000 for the purposes of the undertaking. The committee, however, on a more intimate acquaintance with the subject, were so perplexed with the varied opinions of experts on the several systems, that, before coming to a final decision, they instructed me to make further investigation. This I did, with the result that the committee thought it desirable to visit some of the newest installations, as well as electric plant manufactories in the kingdom. The committee were also privileged to interview several experts, including Mr. Robert Hammond, Prof. Henry Robinson, and Prof. Kennedy. The experience and knowledge thus obtained resulted in the committee being indisposed, at that juncture, to determine the adoption of one or other, or any modification of the high or low tension systems. They instructed me to prepare a set of conditions applicable to the borough, and invite manufacturing contractors, and others, to tender, and that on the receipt of these tenders, either a consulting electrical engineer should be appointed to examine and advise thereon, or that a permanent resident electrical engineer should be appointed, to act in conjunction with myself in determining which system was most fitted for the requirements of the borough. The conditions drawn up for the guidance of those tendering were as follows:—That the estimates were to be based upon the supply of about 6,000 8-candle-power lamps, representing 300 horse-power; that the site of the works would be the corporation property at Whitehead Bridge, plans and full particulars of which were supplied; the fullest information concerning the area of supply, the portion of the work to be executed by the corporation, and the length of streets in which mains were to be laid, was afforded. The tenders, reports, and plans submitted in response to this appeal are now being carefully analysed, and a recommendation will shortly be made to the committee."

Lists, Catalogues, &c.—We have received from Messrs. Richard Crittall & Co., of Manchester Square, W., copies of their illustrated lists of ornamental switch covers, with prices of same plainly marked.

Messrs. Redpath & Paris, of Limehouse, have sent us one of their illustrated catalogues of high-speed noiseless engines. The pamphlet opens with a statement as to the advantages of the noiseless engine. On page 5 is an illustrated description of one of these engines coupled to a dynamo. Altogether the book has been well got up.

A new catalogue has been issued by Messrs. Clark, Chapman & Co., Limited, dealing with a portion of their electrical manufactures. Combined engines and dynamos, belt-driven dynamos, search light projectors, projector hand lamps, switches and switchboards, resistances, cargo lamps, electric cranes, gas motor and dynamo; these and other apparatus are described. We also observe a patent safety cable for mines, which is an arrangement for preventing the risk of explosions in mines consequent on injury to cables conveying electric currents. The illustrations, also the printing and general get-up of the catalogue, are of the first class. A good deal of detailed information in tabular form is given regarding the dynamos. The catalogue deserves commendation.

The Electric and General Contract Corporation v. Thomson-Houston Electric Company.—In the Queen's Bench Division, on Saturday, the case of the Electric and General Contract Corporation *v.* Thomson-Houston Electric Company was heard, being an appeal by the plaintiffs from the decision of Mr. Justice Kennedy, at Chambers, giving the defendants unconditional leave to defend an action which was brought for the return of a sum of £1,000. It appeared that the defendants, who manufacture electrical plant at Boston, U.S.A., contracted to supply the plaintiffs with £7,000 worth of machinery which was required to carry out a contract in this country, and that the plaintiffs paid £1,000 down. Disputes arose, and each side alleged that the other had broken the contract. The plaintiffs now contended that the £1,000 was part payment of the contract price, and that as the contract had been rescinded they were entitled to have it returned. The defendants, on the other hand, asserted that the £1,000 was paid as a deposit, and that as the plaintiffs had broken the contract it was forfeited. They further said that, in any case, they were entitled to keep the amount until the damages they had sustained by the plaintiffs' breach of contract had been ascertained. Justices Wills and Wright dismissed the appeal.

Electric Light at the Royal Exchange.—The Lord Mayor (Mr. Alderman Tyler), as chairman of the Gresham Committee, performed the ceremony last week of turning on the current in connection with the installation of the electric light at the Royal Exchange. There are four arc lamps in the quadrangle, each of 2,500 candle-power, and an incandescent lamp of 100 candle-power in each of the four corners of the ambulatory. The current is supplied by the City of London Electric Lighting Company, Limited. In consequence of the building being washed down periodically by the fire hose the cables attached to the mains have been specially made concentric and lead covered, and all the joints are enclosed in cast-iron boxes filled in with hot bitumen. This is said to be the first time that the interior of the Royal Exchange has ever been illuminated with artificial light, although great inconvenience has hitherto been experienced in foggy weather as a consequence. The installation has been carried out from plans and specifications prepared by Messrs. Shepherd & Watney, Leeds, the contractors being Messrs. J. G. Statter & Co., London.

Redditch and Electric Lighting.—On the 22nd inst. the Lighting Committee of the Redditch Local Board, accompanied by Mr. J. A. McMullen, their consulting engineer, paid a visit to the works of the Rugby Electric Light Company, which were designed by Mr. McMullen. The committee inspected the Dowson gas apparatus and the 100 horse-power four-impulse gas engine, which works with phenomenal smoothness driving a 50-kilowatt Mordey alternator. At full load there are two impulses per revolution, one for each beat of the piston. This engine was built to Mr. McMullen's suggestions by Messrs. Dick, Kerr & Co. It has two double-acting cylinders placed "tandem." Though the installation is alternating and works without any combination of accumulators, the beats of the engine are absolutely imperceptible in the light even at the lightest loads. The coal consumption is exceptionally low, being less than ½d. per unit delivered. Mr. McMullen claims that by the use of cheap gas power, combined with alternating currents and four-impulse gas engines, the smallest towns can be satisfactorily and economically lighted, however scattered.

The Electric Light at Bristol.—Several of the main thoroughfares leading from the central railway station to the heart of the city have now been lighted by electricity for nearly a fortnight with satisfactory results. The Electrical Committee of the Corporation have decided to dispense with the gas in those streets. The demand for private lighting has exceeded anticipations, and necessitated the provision of an additional engine at the works in Temple Back, while still further additions to the plant will have to be made shortly. It was at first intended to light some of the Corporation offices by the new illuminant, but as there is such a demand for incandescent lamps the committee having charge of the matter have resolved to wait, thus placing about 2,000 lamps at the disposal of the Electrical Committee to meet other requirements. Orders have already been received for 14,000 incandescent lamps, being 4,000 beyond the limit of supply contemplated when the present plant was laid down. The Committee are commencing with 90 per cent. of their power utilised.

Fire.—A large five-storey factory, used for making electrical appliances and supplying Halifax shops with electric light, was burned out on 23rd inst. The damage was very heavy, and the electric lighting of about fifty shops has been cut off. The premises were those of Messrs. Blakey, Emmott & Co., telegraphic engineers, of Square Road. The fire spread to the adjoining works of the Northern Electric Wire and Cable Company, completely demolishing them. The loss was covered by insurance, and the company are arranging for the continuance of their business upon other premises. Customers who have placed orders with the company are asked to forward copies of those unexecuted.

Electric Lighting at Crieff.—As we intimated last week, Crieff is about to carry out a system of electric lighting. It is proposed to establish works at Barvick Falls, two miles from the town. Here a 15-inch pipe will have a head of water of 420 feet, and will yield considerably over 200 horse-power. The cost of erecting this motive power will be about £2,500, and sufficient electricity will be developed to supply over 2,000 electric lights at practically no cost whatever for power. The plant necessary to convey the electricity from Barvick Falls to Crieff is estimated to cost £3,200. The whole works will cost about £5,500.

Electric Light at Huddersfield.—The committee of the Industrial Society have been authorised to light up the premises of the central store with electricity. It is stated that the estimated cost will be £1,600, that 550 lights will have to be put in, and, considering that the engine and boiler which they proposed to put in would do other work besides supplying motive power to the dynamo, there would be a direct saving upon the present cost of gas, and an estimated direct saving of nearly 50 per cent. by working their own plant, compared with the cost incurred by taking electricity from the Corporation.

Halifax and Electric Lighting.—A commendable scheme is about to be carried out at Halifax to test the feasibility of generating steam for electric lighting and similar purposes with ash-bin refuse as the only fuel. The power is obtained from Livet's expanding flue steam generators, capable of exerting 260 H.P. when town's refuse is burned. An electrical installation is being put down which will consist of a powerful turbo-electric generator, supplying a projector search light of 25,000 candle-power and a full complement of arc lamps.

Temporary Electric Lighting.—The electric lighting of the Reading Town Hall, on the occasion of the visit of H.R.H. Princess Christian to open a bazaar there on November 23rd and 24th, was carried out by Messrs. S. C. Williams & Sons, electrical engineers, of Reading, by means of 17 high candle-power incandescent lamps, the current for which was supplied by the Reading Electric Supply Company.

A Novelty.—An invention is being brought out by Mr. H. F. Laughton, of a method of improving electric light switches, bell pushes, key hole plates, and similar fittings by the application of luminous paint thereto. The advantages claimed by the inventor are that wall paper will not be soiled by feeling for switches, bell pushes, and such like, as they can be found with ease even in darkness.

A New Company.—It is said that a company is being formed for the purpose of supplying electric light to the town and district of Poole, and also for the laying down of an electric tramway from Poole to Bournemouth. Recently, powers have been obtained for this purpose, and the County Council and local authorities have given their consent to the measure.

Change of Address.—Messrs. Tickner & Partington, electric light contractors, &c., formerly of Bristol House, Harlesden, have removed their offices to their manufacturing premises, "Vulcan" Works, Kensal Rise, Willesden Junction, N.W., whence all communications should be addressed.

Mr. G. Strauss has given up his temporary offices at 158, Strand, and taken more convenient ones at 130, Queen Victoria Street, E.C.

Mansion Lighting.—Hartrigge House, Jedburgh, the residence of Lord Stratheden and Campbell, has recently been fitted up for electric lighting. There are 140 lights for the house, 15 for the stables, and 5 for the laundry, making a total of 160. There is, also, an electric motor in the stable yard for working some small machinery.

Telegraphic Communication.—The Eastern Telegraph Company, Limited, announces that telegraphic communication has been established between its station at Lisbon and the Island of Graciosa, in the Azores. The following islands in the Azores are also open for telegraphic traffic: San Miguel, Terceira, San Jorge, Pico, and Fayal.

Business Alteration.—The "Faraday" Electrical Engineering Company, Limited, have taken over the business carried on for the past ten years by Mr. McWhirter, at the "Faraday" Electrical Engineering Works, Govan. The staff has been thoroughly re-organised and increased, and additions have also been made to the plant.

Electric Lighting at Monmouth.—At Monmouth last week an enquiry was held on behalf of the Local Government Board, regarding a proposed loan of £18,000 for carrying out a complete scheme of drainage and electric lighting for the borough.

Birmingham Cattle Show.—The poultry department is illuminated with the electric light by Messrs. B. Verity & Sons, and several of the stands will also be fitted with the electric light.

Blackpool Electric Lighting.—It is said that Messrs. Fowler & Son, of Leeds, have agreed to take over all the old dynamos, engines, and boilers, and supply new ones.

Electric Light at Haswell.—Messrs. Reid & Co. have about finished the plant for the electric light of the Haswell Co-operative Stores.

CITY NOTES.

Elmore's Patent Copper Company.

THE fourth ordinary general meeting of Elmore's Patent Copper-Depositing Company, Limited, was held on Wednesday, 22nd inst., at the Cannon Street Hotel, E.C., Mr. J. Todhunter presiding.

The SECRETARY (Mr. L. J. Langmead) read the notice convening the meeting.

The CHAIRMAN in moving the adoption of the report and accounts, said that the position of the company was stated in the balance-sheet as truly and completely as possible, and he did not think that there were many omissions. When the present board took office the condition of the accounts was such that it was with extreme difficulty the real position of the company's finances was eventually arrived at. There were also certain items which did not appear in the books at all, and which it was impossible to ascertain. The balance-sheet presented was that of the last year, for which the directors were not responsible. The capital was increased by the preference shares which were issued by the late directors; otherwise it remained the same as on a former occasion, with the exception that the royalties received for the copper-sheet licenses had been reduced by the £1,250 which came into the revenue for last year. On the other side of the account, land was the same, and buildings, plant, and machinery, had received certain additions. The amount written off for depreciation was the same as last year, and was insisted upon by the auditors. The stock-in-trade had slightly increased, and the balance of loss was very considerably augmented; but now, he believed, pretty nearly everything had been written off that ought to be written off. The present board took office on May 26th; the balance-sheet submitted was brought up to June 30th. After then the directors had a very short time in which to organise the factory and put things in order before they were face to face with the most terrible coal strike that ever took place in this country. It had created distress among thousands of people, and had practically ruined a good many manufacturers, especially in the district in which the company was interested. Yorkshire had been worse off for coal than any other part of the United Kingdom. The position had to be faced in order to determine whether the works should be closed, and so save expense, or whether the utmost should be done to carry them on and execute the orders which were in hand. That was a matter of very serious consideration, because the history of the company was well known—how that excuses had been offered in all directions for work that was not done; and the directors felt that if it were to be a repetition of offering excuses instead of executing orders, they might as well close the works for good. It would be useless to go again to their customers and say they had had another mishap, but that they would be in a position by-and-bye to execute orders regularly; so the directors followed the course which commended itself to them, viz., they used their most earnest endeavours

to obtain coal. Had it not been for the intervention of Mr. Dale, one of the directors, that would not have been possible; as it was, they received it in driblets, at great expense and after great delay, the block on the railway being so great that it sometimes took as much as three weeks to get coal from Durham to Leeds. Coal, however, was obtained, and, except on two occasions, there was sufficient on hand to keep the works going—at any rate, sufficient to enable all pressing orders to be executed, and he could say that nobody demanded from them the goods which had been ordered without obtaining them. It had not, of course, been done without expense; but the directors felt it ought to be done at any cost. Another source of great anxiety had been the position with regard to the Wire Company. On the last occasion when he addressed the shareholders a question was put to him as to whether it was possible to carry on the Depositing Company independently of the Wire Company. He said, "Yes, it could be done; but it would be very difficult." Further experience showed him that the Depositing Company was absolutely dependent upon the use of the furnaces of the Wire Company for a supply of copper. If the furnaces of that company were not available, the Depositing Company would have to build furnaces of its own, and also construct a taller chimney, which would cost, altogether, about £3,000. He wished shareholders clearly to understand how necessary it was that the company should have the continuous use of those furnaces. They had received every assistance from Mr. Atkinson, the chairman of the Wire Company, and he (the speaker) was confident that the use of those furnaces would be continued so long as Mr. Atkinson had the management of affairs; only there was a fear that the finances of the Wire Company were in such a condition that it was quite possible the works would not continue under the present board. With regard to the financial position of the Wire Company, the meeting would recollect that there was a debt owing by it to the Depositing Company, and also a bill which had been drawn upon the Wire Company prior to his assumption of office. That bill was dishonoured, and the Depositing Company was bound to pay, and did pay it. An amount of £6,000 was raised in debentures to pay off the creditors of the Wire Company, and the directors engaged to liquidate the debt to the Depositing Company by handing over the copper which was then in their works. Owing to mistakes of a very serious character on behalf of the trustees who were appointed under that arrangement, the engagement was not carried out; no copper had been received, and the debt had not been discharged. That would show that the capital which existed when the present board took office was reduced by about £2,000, in consequence of the non-fulfilment of the engagement by the Wire Company. With regard to the condition of the works at the present time, the directors had expended very much less than they had anticipated would be necessary to put the machinery and works in absolute order. The works were now in good condition, and the company was ready to execute large orders as soon as coal could be obtained. He, like other shareholders, was more or less sceptical as to the promises of orders for the company's goods; but now the state of promise had become a state of certainty. There were on the books now absolute orders, which could be executed, to the extent of 65 tons of finished output. The larger portion of those orders had come in within the last six weeks or two months; so that, while very little had been in progress at the works, the directors had not been idle in putting forward the experimental tubes to obtain orders. The experimental tubes, after being tested at the works, had been sent to the large shipbuilders in the North for them to experiment upon, with the result that they were pronounced excellent in every respect. They had stood every test, and some of those firms had entered into contracts for similar tubes, and there was no doubt, judging by the orders that were coming in, that there would now be continuous commissions for the same tubes. The business in calico rollers was progressing steadily, and increased orders were being received for them. The company had also been approached by some large firms who made shafts for the great ocean steamers, and he was satisfied that they had arrived at the conclusion that it would be the Elmore process, and the Elmore process only, that would cope with the great difficulty of coating those shafts. If that should be successful—and some shafts were now being coated experimentally—there was an immense trade opened out beyond what they had hitherto expected. The whole working capital of the company, when the present board took over the administration, could not have been reckoned at more than £9,000 to £10,000. After making certain deductions, the working capital had necessarily been reduced to about £4,000—a sum quite inadequate for the successful working of such a company. He did not like to again bring forward a tale of woe, to which the shareholders were accustomed; but, had it not been for the coal strike, there was no reason to suppose that the output would not have gone on increasing until eventually 10 tons or 12 tons a week were reached. From what he had seen, he could say that it only required diligent work and sufficient capital to enable the company to turn the corner. With the exception of £390, the whole of the preference shares had been subscribed, and there was now only one course—viz., to issue debentures. As there was a possibility, and even a probability, of orders being received for shafts, which would entail increased outlay on machinery, the board proposed that an issue of £10,000 of debentures should be made, bearing interest at the rate of 6 per cent. In order to show his confidence in the undertaking, he should subscribe for £500, and he trusted the shareholders would support him to the utmost of their ability. No issue had yet been made, but if events justified the course, a circular would shortly be placed in the hands of the shareholders. The directors proposed that the debentures should run for five years, the company having the option of paying them off at six months' notice, at the rate of £102 for every £100 of debentures. The position of the Wire Company was at present one of menace to the Depositing Company, and he thought before long the time must come to resuscitate those works in some shape or another. His own view was that the two companies ought never to have been separated, as, for working purposes, they were practically inter-dependent. Another point was that, sooner or later, the capital would have to be written down, the sum now standing to the debit of profit and loss being practically £34,000. For the sake of convenience, he would suggest that when the auditors were appointed, a local firm should be chosen. The shareholders were not for a moment to imagine that the company was in any kind of difficulty, for they had copper and capital to go on with, though not of sufficient amounts to execute prospective orders.

Mr. J. W. DALE, in seconding the resolution, said he could endorse the statement made by the chairman. A business such as theirs could not be developed in a day, but he had no doubt it had a promising future.

Mr. EWEN congratulated the chairman on his statement, which, he said, seemed to him to bear the impress of truth. The sum asked for was by no means unreasonable, and he should be willing to take up his quota of it.

Mr. J. J. ATKINSON thought the way in which the present board was conducting the business was the correct one. The Wire Company would, he hoped, in a few days deliver the copper promised, and he was glad that Mr. Todhunter had come to the conclusion that the Depositing and Wire Companies should never have been separated.

Mr. SHURMER thought it would be useless to reduce the capital of the company until there were profits to divide.

The CHAIRMAN, in reply, said that due intimation of the course proposed would be given to the shareholders when the time was opportune.

The report was then unanimously adopted.

Mr. Joseph Todhunter was re-elected a director, and Mr. J. W. Close, of Leeds, was appointed auditor.

A vote of thanks to the directors brought the proceedings to a close.

International Okonite Company.

AN extraordinary general meeting of this company was held on Saturday, at the City Terminus Hotel, Mr. Samuel Pope, Q.C, in the chair, to consider the confirmation of the resolutions passed at the meeting on the 27th ult., for changing the name of the company to the Okonite Company, Limited, and for making certain alterations in the articles of association.

The CHAIRMAN reminded them that at the last meeting they found themselves practically at the mercy of the American shareholders, who held a preponderance of the voting power. During the discussion on that occasion objections were raised to some of the propositions which had emanated from the other side, notably one for abolishing the power of the company to purchase its shares—a change which would affect their standing on the Stock Exchange. The resolutions were passed, but the gentleman who held the proxies of the American shareholders said he would represent to his clients the views which had been expressed by the English shareholders. A letter had since been received from America agreeing to modify the resolutions to the extent of not interfering with the existing article as to the purchase of the shares by the company, and therefore the resolutions would now be submitted for confirmation *minus* that point. He held that the best thing they could now do was to agree to the resolutions.

Mr. WILLIAMS then moved the confirmation of the resolutions, with the modifications referred to.

Mr. VAUGHAN STEVENS, in seconding the motion, stated that the capital of the company was £340,000, and that Mr. Williams had lodged proxies representing £165,490 in favour of the motion.

The CHAIRMAN stated that the board held no proxies. The effect of the proposals was to transfer the management to America.

Mr. GLADSTONE said that the Americans, who had sold the property to them at 10 times its value, now asked that it should be placed at their entire disposal.

The CHAIRMAN, in reply, stated that that was no doubt the individual opinion of many of them, but he felt powerless in face of the proxies which had been lodged by Mr. Williams. The position was that the American business was making profits, which the American shareholders objected to giving up to make good the losses on the English business. At the suggestion of the American directors the works at Manchester had been closed, but possibly they might be reopened at some future time. Speaking as an ordinary shareholder, he felt that the only chance he had of getting a dividend lay in the surplus profits of the American business.

After further discussion the motion was adopted.

Brazilian Submarine Telegraph Company, Limited.

—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30th last, and payable on December 21st. The transfer books of the company will be closed from December 14th to 20th, both days inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 26th, 1893, amounted to £895; week ending November 27th, 1892, £893; increase £2; total receipts for half-year, 1893, £17,220; corresponding period, 1892, £17,137; increase £183.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 24th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,379.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation November 22nd.	Closing Quotation, November 29th.	Business done during week ended November 29th, 1893. Highest.	Lowest.
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	44 — 46	43 — 45	45	43⅜
2,932,680£	Do. do. 6 p. c. Preferred	Stock	83 — 84	82½ — 83½	83½	81½
2,932,680£	Do. do. Deferred	Stock	7⅜ — 8¼	7⅜ — 8	7⅞	7⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11¾ — 12¼	11⅝ — 12¼	12⅛	12
18,700£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ — 3	2⅝ — 2¾	2 15/16	2⅝
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2¼	2⅜	2 5/16
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	106 —108	106 —108	108	106½
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4¾ — 5¼	4¾ — 5¼	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½ — 11⅝	11½ — 11⅝	11⅝	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅝ — 13¼	12⅝ — 13¼	13¼	13
10,000,000$	Commercial Cable, Capital Stock	$100	140 —150	140 —150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16 — 3/16	1/16 — 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4¼ — 4⅝	4¼ — 4⅝	...	...
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛ — 11⅜	11⅛ — 11⅜	11⅜	11 5/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ — 15	14⅜ — 15	14 15/16	14⅜
70,000	Do. 6 p. c. Preference	10	15½ — 16½	15½ — 16½	16⅛	16
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	113 —116	114 —117	116	115
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅛ — 15⅜	15¼ — 15½	15⅜	15⅛
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	113 —116	114 —117	114	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	103½	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	103½	102½
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	104 —107 %	105 —108 %	107	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	... ...	... ...	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	¼ — ⅜	¼ — 3/8	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅜ — ⅝	⅜ — ⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	½ — 1½	½ — 1½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8⅜ — 8⅝	8⅜ — 8⅝	8⅝	8⅜
180,042	Do. do. 6 p. c. Preference	10	14⅝ — 15⅛	14⅝ — 15⅛	15⅛	14 15/16
150,000	Great Northern Tel. Company of Copenhagen	10	20 — 20⅛	20 — 20⅛	20 1/16	20 1/16
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 —106	103 —106	105½	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22	21½
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 43	40 — 43	41½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ — 4¾	4⅝ — 4⅞	4 7/16	4 1/16
15,000	Do. do. fully paid	5	6 3/16 — 6 7/16	6½ — 6¾	6⅝	5⅝
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5⅛ — 5⅜	5⅛ — 5⅜	8½	4⅜
6,295	Do. do. Pref., £6 paid	10	6 1/16 — 6 3/16	6⅛ — 6¼	6⅛	...
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£10 paid)	10	7¼ — 7⅜	7¼ — 7⅜	...	...
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	106 —109	106 —109	108	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1½ — 2⅛	½ — 1½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	2 — 3	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 5	4⅜ — 5	4 15/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	14⅜	14⅛
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½ — 14½	13½ — 14½	...	...
113,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ — 5½	5¼ — 5½	5⅜	5 5/16
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —115	113 —115	113½	113
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4½ — 5½	4½ — 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	102 —105	102 —105	103⅜	...
11,802	Reuter's Limited	8	5½ — 6½	5½ — 6½	...	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6 — 6½	6 — 6½	6 1/16	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8⅜	8 1/16
3,381	Submarine Cables Trust	Cert.	113 —118	113 —118	116⅜	...
78,942	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2 — 2⅛	2 — 2⅛	2⅛	...
37,350	Telegraph Construction and Maintenance, Limited	12	35 — 37	35 — 37	37	36½
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	104 —107	104 —107	...	...
58,000	United River Plate Telephone, Limited	5	2 — 2⅛	2 — 2⅛	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	99	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103	99 —103	...	...
64,242	Western and Brazilian Telegraph, Limited	15	5½ — 6½	5½ — 6½	6⅛	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5¼ — 5¾	5¼ — 5¾	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1 — 1½	1 — 1½	...	...
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅛ — 1⅜	1⅛ — 1⅜	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10½	10
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9 — 10	9 —10	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	107 —110	108 —111	109	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 —118	113 —118	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	102 —105	102 —105	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 5⅝	5 — 5⅛	5 3/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅛—6⅛.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 107—109.—Electric Construction Corporation 6 per cent. Debentures, 87—92.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5¼.—House to House Company (£5 paid) 1—2.—Do. 7 per cent. Preference of £5, 4⅜—5¼.—Do. 6 per cent. Debentures of £100, 97—103.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 4⅜—5¼, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6¼—7.—Liverpool Electric Supply, £5 (fully paid) 6⅜—6¾.—Do. £3 10s. paid, 4⅛—4¼.—London Electric Supply Corporation. £5 Ordinary, ⅞—1⅛.—Manchester Edison and Swan Company £9 (£1 paid), ⅜—⅝.—Queen Anne's Mansions Lighting and Heating 6 per cent. £100 Debentures, 101—103.

Bank rate of discount, 3 per cent. (October 5th, 1893.)

FUEL ECONOMY.

THE fuel consumption of a pumping station bears a small ratio to the business turnover as compared with that of an electric light station. To take a case in point, the Lambeth Water Company had a coal consumption test made of one of their engines on February 1st of this year, and found that they could pump over 6¼ million gallons for 8·6 tons of coal consumed. Probably their fuel cost considerably less than twenty shillings per ton. Taking the average household at five persons, and the consumption per head at 30 gallons per day, the water pumped by their fuel would be sold by the Lambeth Company for £342. Even if sold by meter at the fair price of 6d. per 1,000 gallons, this amount of water would bring in £156. We believe, however that the larger amount is nearer the mark, as it is based on the legal charges of the Lambeth Company. Whichever figure be taken, however, it is clear that the fuel expenditure is a very small fraction of the selling price of the produce.

Now the fuel of a metropolitan lighting station costs in the best of cases close upon one penny per unit, and in some instances, nearly twopence halfpenny, or an average of 1½d. for each 7d. charged: these figures being a rough approximation of the fuel cost and charge per unit of a dozen London electric light companies. Fuel thus costs over 20 per cent. of the gross income as against but 1 or 2 per cent. in the case of the water companies. Any deficiency in the quantity or quality of the electric product can be easily met by the consumer who has the power at once to shut off both current and payment, whereas the water companies' deficiencies and extortions can be met only by expensive legal process. It would appear then that fuel economy is of far greater importance to the electrician than to the water company, and yet the idea does not seem to be carried into practice. In North country practice, the rate of fuel consumption is often as high as 21 or even 25 pounds per square foot per hour with ordinary slack. South country practice is very frequently to burn only 12 or 15 pounds. Wherever the fuel consumption is moderate, there is always good reason to look about for a cheaper fuel than best Welsh or other high priced coal. Men who have paid special attention to fuel economy have often effected great savings by using dust fuel mixed with coke breeze, and sometimes assisted by a slight fan draft. There are, of course, difficulties in dealing with such fuel, not the least of which is the closeness with which the particles lie and the difficulty with which air finds its way into the mass. The idea of mixing dust coal with the breeze is that the breeze may be cemented by the coal into larger masses during the coking of the dust, and this class of fuel is advocated for use with mechanical stokers, whose vendors, indeed, claim that their machines are aids to economy, not because they raise steam with less fuel, but because they permit inferior fuel to be employed that otherwise could not be used at all or with difficulty. It is by no means the case that these cheap mixtures cannot be fired by hand where the grate area is sufficient to permit of this being done. We have referred above to the difficulty in getting air through the mass of close lying fuel on the grate. This, indeed, is the one difficulty with such fuels—the particles are so small that they pack closely and prevent air from passing in sufficient volume. What is wanted as an addition to the mixture, is a quantity of air spaces, so that when the coal dust has coked the mass into one adhering sheet there shall be numerous small air channels through it. Air spaces cannot be purchased but they may be secured by simple means. Clearly, some easily combustible substance which would only endure in the fire until the bituminous dust has become partially coked, would secure the end in view, for such a substance would burn away and leave behind its form in the shape of an air cavity. We recently saw this idea carried into practice by the use of spent tan bark which was mixed with the coke and dust coal in a fairly wet state, that is, it was used just in such a state as it arrived at by standing to dry in heaps under cover, but no special efforts were made to dry it. Though of small value as fuel, it had at least more than enough calorific power to evaporate its own load of water, and in so far was no loss, but probably a slight gain, as actual fuel. Its chief use was, however, its secondary purpose of lightening the fuel bed, maintaining porosity in the coked mass, and disappearing like the wax in the *cire perdu* method of statuary casting, to make room for something else. Doubtless, there are other waste products which would serve the same useful purpose; notably the waste of a cooperage, for example.

Probably mere sawdust or shavings would not serve the purpose. It becomes a matter for speculation whether the working up of sawdust and other waste might not even be made to pay, the working up only going so far as to mass the stuff into larger fragments of a bulk sufficient to resist too rapid combustion, and to afford the required air passages when consumed. With the tan bark waste the contained moisture appears to give the length of endurance necessary. Its effects seem good enough to justify its use in cases where at hand in sufficient quantity. W. H. B.

SOME RECENT RESEARCHES ON ELECTROLYTIC DISSOCIATION.

ACCORDING to the principles laid down by W. Nernst (*Zeit. Physikal. Chem.*, Vol. iv., p. 372), it is possible, from experiments on the solubility of a sparingly soluble salt in aqueous solutions of another salt containing one ion in common with it, to calculate the degree of dissociation of the one salt, provided that that of the other is known. But while investigating the truth of this proposition, A. A. Noyes (*Zeit. Physikal. Chem.*, Vol. ix., p. 632) observed a certain discrepancy between the numbers obtained for the degree of dissociation of dissolved salts from the solubility experiments which he made, and those derived from the electrical conductivities. This discrepancy, and more especially the opinion which Noyes has expressed, that the former series of numbers is more trustworthy than the latter, and that water takes a part in the electrolysis of a salt solution, has recently induced S. Arrhenius to submit the question to an experimental examination. He describes his investigation in the *Zeit. Physikal. Chem.*, Vol. xi., p. 391, and in substance the results are as follows:—The electrolytic dissociation, calculated from the solubility, differs enormously in the case of the same salt, according to whether the sparingly soluble salt with which this is combined is more or less soluble. He considers, therefore, that no agreement can be obtained between numbers which apply to one and the same salt, so that solubility experiments do not give trustworthy results for the determination of the electrolytic dissociation. The cause of this is, apparently, that the law of "mass action," upon which the calculation of the experimental results is based, is not applicable to strongly dissociated electrolytes.

Concerning the electrolytic dissociation of water, there are two papers which have recently been published, which are worthy of attention. They are both to be found in the *Zeit. Physikal. Chem.*, Vol. xi. At page 492, J. J. A. Wijs discusses some experiments, in which methyl compounds were used for illustration. Methylic acetate and water react to form methyl alcohol and acetic acid, or an acetate, at a rate which is directly proportional to the number of hydrogen ions or hydroxyl ions present in the solution. The reaction conditioned by the hydroxyl ions proceeds much more rapidly than that conditioned by the hydrogen ions. The water appears to behave, chemically speaking, both as a weak base and also as a weak acid, so that it is assumed to be slightly dissociated into hydrogen ions and hydroxyl ions.

$$H_2O = \overset{+}{H} + \overset{-}{O}H$$

To measure the extent of this electrolytic dissociation, Wijs prepared an aqueous solution of methylic acetate, carefully sterilised and free from acid impurity, and from time to time titrated it with standard alkali, in order to ascertain the amount of acetic acid liberated. The action was supposed to be caused entirely by the hydroxyl ions, and only the first few titrations were considered, for the free acetic acid contributes a considerable number of hydrogen ions as the decomposition proceeds. From the rate of decomposition, it appeared as if the water were a $0{\cdot}1 \times 10^{-7}$ normal solution of hydroxyl ions, or, in other words, that water is to this extent dissociated under the conditions of experiment.

The same subject is considered from a different standpoint in a paper commencing at page 521, by W. Ostwald. The conclusion to which his investigation leads him is, that it is possible to calculate the concentration or osmotic pressure of the hydrogen ions in the alkaline solution, and of the hydroxyl ions in the acid solution, from the electromotive force of a gas cell consisting of two electrodes saturated with hydrogen, one immersed in an alkaline and the other in an acid solution. The concentration of these ions in pure water may then be calculated. The value of the observed E.M.F. was about 0·7 volt, hence the concentration of the hydroxyl and hydrogen ions in water is $0{\cdot}9 \times 10^{-6}$.

At page 495 there is a further paper on electrolytic dissociation by A. A. Noyes, who considers the dissociation of acid salts. From experimental results he deduces a general relation which is in harmony with Trevor's results, q. v., *Zeit. Physikal. Chem.*, Vol. x., p. 32. Finally, at page 529, H. C. Jones, from experiments on the freezing point of very dilute experiments, shows that the dissociation ratio of salts may be more correctly ascertained from the electrolytical conductivity (Arrhenius's idea) than from the solubility relations, as Noyes suggests.

WASTE FURNACE HEAT UNDER STEAM BOILERS.

In calling the attention of the readers of *Cassier's Magazine* to the question of utilising the waste heat of puddling and other metallurgical furnaces, Mr. Ashworth appears to say that the economy of this was recognised in the early days of American iron-working, but has since fallen into disuse.

We know something of this economy in England. Some of our most disastrous explosions have been those of Rastrick boilers placed in the middle of several puddling furnaces, and receiving heat from these. They were supposed to be protected from the direct impact of the furnace gases by brickwork shields; but, in practice, these shields often fell into disrepair, and the boiler plates have been seriously wasted where exposed to the severe heat, and when explosion occurred the fatalities were frightful, for these Rastrick boilers stood on end, and were large structures cased in strong brickwork, and it was the conversion of the bricks into projectiles which was responsible in many cases for the fatalities in the crowd of men working at the furnaces.

Mr. Ashworth refers to the water-tube boiler as having given a fresh incentive to the efforts made to save some of the waste heat from iron furnaces. Combustion is practically complete when the gases leave a furnace; and the water-tube boiler, unsuitable as it appears to us for steam-raising under ordinary conditions with bituminous fuel, appears to be exceedingly well adapted for use with waste heat, and our author illustrates a Babcock boiler connected to a puddling furnace, being placed directly over the furnace, from which by a short up-take of brick the gases are led to the boiler and delivered horizontally just above the level of the fire-grate, which is removed and replaced by a brick floor.

The Cook water-tube boiler resembles a tall vertical cylinder boiler in which the two ends are retained and the middle and greater portion of the shell is replaced by a large number of tubes. The furnace gases in this case are admitted round the lower chamber, which is shielded by brickwork, and are then compelled to travel between the tubes, which fill, at two points, the brick chamber that surrounds the boiler. This boiler resembles, in fact, the Rastrick boiler shell with the above tubular alteration.

The Cahill boiler is very similar, but the long tubes are disposed in a conical manner, and the furnace gas admitted at the middle of the lower chamber by a bricked opening which occupies the space left by the divergence of the tubes.

The trouble with all tall vertical boilers is the want of circulation of water, which is liable to cause overheating and priming; the arrangement of both these last-named types is such that the down-flow will probably take place *viâ* the ring of tubes furthest removed from the locality of passage of the heated gases, the danger coming in when the heat is very intense, and of liberal amount, for then every tube might become filled with steam, and burning would inevitably ensue.

The illustration of the Cahill boiler shows that the feed is led into the upper chamber, and conveyed by short tubes from an encircling ring into each of the outer ring of tubes, which we observe to be of greater diameter than the remainder, thus ensuring, as far as can be done, that circulation shall take place. It is claimed that the vertical tubes clear themselves of scale when the boiler is cooled down.

These vertical water-tube boilers seem worth the attention of those desiring to use the waste heat from furnaces; for, even if burned, it is probable that the giving way of one tube would sufficiently relieve the boiler to prevent disaster.

The author looks on such a method of steam-raising as merely an auxiliary to the main steam supply, owing to uncertainty of the heat supply, and appears to indicate his preference for an arrangement whereby regular firing can be applied in a few minutes, as is now being done by the Aultman and Taylor Machinery Company, of Mansfield, O.

REVIEWS.

La Mort et les Accidents causés par les courants électriques de haute tension. Par le Docteur FRANCIS BIRAUD, Médecin stagiaire au Val-de-Grâce. A. Stork, Lyon; G. Masson, Paris.

(*Concluded from page* 554.)

In considering the question of the *modus moriendi*, the author quotes two more hypotheses, one by Tatum and the other by Donlin, both of which he dismisses as inconclusive, and he completes the chapter by expressing his belief that death is brought about by the reflex method. In the succeeding chapters he brings forward a mass of clinical notes and pathological material, an examination of which, he maintains, necessarily leads us to adopt the same view.

Under the heading of electro-pathology the author deals with a classification of the ætiology of accidents. This is, of course, important and instructive, for cases are cited of different individuals being exposed to the same voltage of current with results that vary in each case. These results vary within the limits of a slight concussion and instant death. The following causal classification is suggested:—

a. The victim's body forms, by double contact, a short circuit between two conductors at a different potential.

b. The victim's body forms a shunt between two points of the same conductor.

c. The body of the victim forms a connection from one conductor to earth.

Among the accidents cited is one relating to an electrical engineer who, as a result of an electric shock, fell senseless to the ground; it is interesting to note that he experienced absolutely no pain whatever. This sudden abolition of cerebral function is difficult to explain, for the inhibitory act must have occupied a less time than the transmission of a nervous impression to the brain. This instantaneous loss of consciousness constitutes one of the advantages to which the advocates of electrical execution lay claim.

Among the numerous accidents described is one in which special attention was given to the microscopic appearances of the skin in the neighbourhood of a blister on the hand of a man who had been killed by touching a dynamo at the Health Exhibition in London in 1884. This blister was one-half inch long by one-eighth broad; it looked like a burn, but there was no congestion around it nor was there any smell of burnt flesh. One portion of the skin was treated with osmic acid, another by chromic acid and alcohol. The sections were made at right angles to the surface of the skin and transversely to the finger. We give the appearances in extenso:—

I.—*Epidermis.*

1. *Stratum corneum.*—(*a*) Cavity. (*b*) Swelling of the cells in the marginal region. (*c*) Condensation and partial fusion of the central cells.

2. *Stratum lucidum.*—More apparent and thicker at the periphery.

3. *Stratum Granulosum.*—Partly fused with the preceding layer in the centre of the blister.

4. *Rete Mucosum.*—(*a*) Distension of the nuclear vacuoles.

(*b*) Marked contraction of the nuclear substance. (*c*) Fibrillar arrangement of the protoplasm at the periphery and dissociation of the fibrils centrally.

II.—*Dermis.*

1. *Connective Tissue Layer.*—(*a*) Papillæ flattened. (*b*) The tissue forming the base of the blister is nearly homogeneous.

2. *Capillaries.*— (*a*) Capillaries contracted. (*b*) Endothelial cells contracted. (*c*) Blood coagulated and having a fibrillar striation.

3. *Nerves.* — Remarkable definition of Meissner's corpuscles.

III.—*Adipose Tissue.*

1. *Matrix.*—Unaltered.
2. *Fat Cells.*—Normal.
3. *Sweat Glands.*—Cells fused; striated appearance of the contents of the ducts in the cutis vera.
4. *Nerves.*—Doubtful swelling of the axis-cylinders.
5. *Vessels.*—Arteries very contracted.

The above appearances are, therefore, not at first sight to be distinguished from those of an ordinary burn.

A rather interesting account is given of the symptoms induced in a lady in Boston, U.S.A., by slight electric shock. The author looks upon the case as one of "hysterical monoplegia" or "traumatic neurosis" of electrical origin, which he says Charcot has described at the Salpêtrière, and cautions medical men against being taken in by cases in which the patients have simulated the effects produced by an electric shock where no such shock has been received. He cites two instances of the kind in which the disturbance was purely functional, and all the symptoms of a hystero-traumatism were exhibited.

In order to get some idea of the pathology of death by electricity, the author has collected a considerable number of reports on the post-mortem appearances of fatal cases. He points out, however, that none of the changes can be said to be absolutely characteristic of such a death.

Dr. Biraud has drawn up a scheme, complete in every detail, for the guidance of the medical expert in cases under consideration.

It was, of course, only to be expected that in a work of this kind some space would be devoted to a description of the method of executing criminals which obtains in the United States, and which is known by the name of electrocution. And, indeed, a very good description is given of the circumstances that led to the adoption of this form of execution. This is followed by an account of the electrocution of several criminals, that of MacElvaine being described in extenso. The manner in which this man's death was brought about is of so revolting a character as to make it quite clear that this latest method of carrying out the extreme penalty of the law is in no wise free from the objections which were raised against the continuance of the older methods. In fact, the author does not hesitate to condemn in strong terms the action of the physicians, who, in the United States, have constituted themselves the "auxiliaries of the executioner, and who, in so doing, have lost sight of the dignity and character of the profession to which they belong."

The final chapter is devoted to hygienic considerations, and, so thoroughly do we agree with the author's views on this subject, that we cannot help quoting his concluding sentence. He says: "Electric lighting realises nearly all the desiderata of modern hygiene. The accidents to which it may give rise are infinitely less numerous than with other systems of lighting; but their number may, even with higher tensions than those now in use, be very considerably reduced by well considered measures and regulations."

There is no question that Dr. Biraud has treated a very difficult subject in a most able and complete manner. He does not appear to have spared any trouble in obtaining the most reliable information from all parts of the civilised globe. The particulars which he has thus collected, have been arranged in the most logical order and dealt with in a manner which reflects great credit to himself as a man of science. The subject is one which is of pressing interest both to the electrician and the physician, and while, perhaps, on account of the physiological considerations introduced into the work the book will appeal more to the latter than to the former, there is a great deal of information of which the electrician will be glad to avail himself. The instructions relating to the immediate treatment of those suffering from the effects of an electric shock, may be easily carried out by any layman, and all those whose occupation renders them liable to such accidents, should certainly make themselves masters of these directions.

We can confidently recommend the perusal of this book to all professional men in whose range of work electricity finds a place; the fact of its being written in French, is now no bar to its being read; for the members of every profession have found it necessary to acquire a reading knowledge of both French and German in order to keep themselves *au fait* with the advances of science, having their origin as they do in what is practically a cosmopolitan laboratory.

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THE PRIMARY ACTION OF THE GALVANIC CURRENT.

BY J. MOUNT BLEYER, M.D., and M. MILTON WEILL, M.D.

(*Concluded from page 557.*)

OUR PLAIN VIEWS REGARDING ANIMAL ELECTRICITY.

The existence of animal electricity is acknowledged. The origin and action, however, are the points upon which electro-physiologists are not quite clear. Those who have given the subject some consideration dismiss it by establishing its connection between chemical action, heat, and animal electricity. They rest content in discussing the three conditions without attaching the slightest importance to the precedence of one or the other of them. Chemical action we are told evolves heat, and so tissue metamorphoses and oxidation go on. They are satisfied with the evidences of the existence of animal electricity, that it can be measured, and that it is one of the great trinity upon which life rests.

It is in view of this condition of the investigations upon this question that we approach it with much trepidation and fear lest we be charged with being too radical in our deductions; we can almost see doubt written upon the faces of many of this distinguished gathering, and we can almost hear you say, "Well, are you going to settle the question?" Settle the question or not, still we have the boldness to advance a probable solution of the problem, and we ask you to follow closely our experimentation and the deductions we have drawn and based our opinion upon.

We will not take up your time by rehearsing the observations of the various electro-physiologists who have enlightened us in animal electricity. To do so we would in fairness to all be obliged to begin with Matteucchi and so on up to the present day, without omitting a single one, for each of the observers has welded a link in the chain of result, and to leave out a link would mean to destroy the integrity of the chain.

Let us for a moment consider the observations of Dutrochet, and we may get a clue to the true function of animal electricity. He observed that if the positive pole of a battery be dipped into pure water and the negative in gum water, endosmosis continued more energetically.

Onimus later on discovered that with a reversal of this order of pole, endosmosis too was reversed. It is but fair, reasoning again by analogy, to assume that the electricity in the body exercises precisely the same physico-chemical action. We have already called your attention to the observations of Gay Lassan. Whenever the so-called catalytic action takes place in the living tissue, is it not equally fair to assume that animal electricity is the prime mover? Can there be any question that electricity, galvanic, with its electrolytic powers, the ready manner with which it decomposes the salts, coagulates albumen in the vessels of our laboratories, has a like action on the tissues and fluids of the living organism?

It is apparent, we hold, that animal electricity not only influences the whole system of nutritive operations, but also directs them.

Time and again we have electrified animals and observed that under certain conditions of electrification, the animals threw off a greater amount of urea and carbonic acid than under ordinary conditions.

Urea and carbonic acid! and what is the significance of such an increase in the waste products?

Nothing more than, and nothing short of increased chemical action, increased tissue metamorphosis, the increased evolution of heat; but the electricity, the animal electricity—that remains unaccounted for.

Dutrochet and Onimus showed us the action of the anode and the cathode in endosmosis, and left us to apply it to the physiology of nutrition. Now let us do so and account for the function of animal electricity if we can. As we have already intimated, the order of action is animal electricity first, and why, because we must have polarity before we can have chemical action and its natural result, heat.

Subject a solution of the idodide of potassium to electrification and you free the iodine. Inject a quantity of this fluid into the blood of a living animal and then subject the animal to electrification, and in a very few minutes starch papers held in contact with the parts surrounding the positive pole will indicate that the iodine

is set free by the action of that pole. Note the transfer of the chemical action from the laboratory to the living body; are the two not singularly alike?

Unfortunately we have not been able to isolate the poles of animal electricity, and hence it is that our tests on animals similarly injected, yet not electrified, give us such indistinct reactions, that we hesitate to announce them as positive results.

Yet all this points to the one conclusion, and the one deduction, that animal electricity comes first; that is the prime factor in all the processes of change, of chemical action, or otherwise, within the living body. That without its stimulus of polarisation, no chemical action can be called into life, and consequently none can go on; and tissue metamorphosis, which is life itself, must cease.

Before concluding, allow us a word or two upon ozone, its physiological and therapeutical value, which are not under discussion, and are hardly properly to be considered in the limits of this paper. We have dealt with ozone generated from the oxygen within the body, and it is in this form that it plays its so important *rôle* in the oxidation of the tissues. There seems to be some doubt as to possibility of introducing ozone in its pristine integrity into the system. It may be a feat within the range of possibility, judging from the voluminous literature upon the subject that has been published only within the past year or more, yet from our experience in handling it, we prefer to regard it as an agent that performs its most useful work upon the field where it is ushered into existence, where nature calls it into life because it is needed to peform important duties.

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR OWN CORRESPONDENT.]

If a census were taken of all the electric motors in the colony, the total sum would be very small, but a start is being made in the right direction, as we have had but recently completed an electric tram in Sydney and in Hobart. The Hobart Electrical Tramway Company, Limited, an English company, purchased recently from a local syndicate the concession of a perpetual lease of the necessary roadways, and entered into a contract with Messrs. Siemens Bros. for the supply and erection of the necessary steam and electrical plant and rolling stock. Everything has been in readiness for some time past, but here, as elsewhere, the telephone interference trouble has intervened to prevent running, and the telephone system being under Government control, has so far had the upper hand.

The total length of the tracks is about 10 miles from the railway station to Lower Park Street, along Macquarie Street to the Cascades, from the corner of Macquarie and Elizabeth Streets to Newtown, and from the corner of Macquarie and Murray Streets to Sandy Bay. The steepest grade is on the Newtown line, where for about 350 yards there is a 6 per cent. rise. In other places there are some pretty severe curves and grades. The rails are 40 lb. Vignoles rails, with guard rails throughout, the joints being bridged with copper strap riveted to the rails. The track is single, with sidings for passing. The overhead construction is of the wire suspension type, with poles on each side of the street, galvanised steel wires being used for suspension. It has been found necessary in some places to clear the telegraph and telephone wires to cover the tops of the poles, which are mostly iron. The cars, which are two-deckers, and carry 24 passengers inside and 24 out, were built by the Lancaster Waggon Company, of teak, ash and mahogany. The power house and car shed are situated at the lower end of Macquarie Street, near the Hobart River, and built on cement concrete set on piles. The power house consists of a galvanised iron shell with wrought-iron girders and columns, with brick and wooden partition walls. It was designed in England, and sent out ready to erect. The chimney stack, 90 feet high and 5 feet diameter, is of wrought-iron, riveted throughout and stayed with stranded steel stays. There are four of Marshall's multitubular locomotive boilers, giving steam at 160 lbs. pressure to three Willans central valve high speed compound engines running at 350 revolutions. Two No. 5 Worthington steam pumps pump the feed water through two Marshall's feed water heaters of 100 H.P. each. The boilers and steam pipes are coated with Bell's asbestos composition, the steam pipes being arranged in a ring main to enable any boiler or any engine to be worked separately. There are three compound wound 125-unit Siemens dynamos, giving 250 ampères each at 500 volts, coupled direct to the engines; the shaft of each carrying a fly-wheel 4 feet 2 inches in diameter, each engine and dynamo being fitted on one bed-plate. Two Siemens 15 H.P. motors are used for each car, geared to the car axles with single reduction spur gearing working in oil. The work has been carried out under the supervision of Mr. A. C. Parker.

In Sydney, the Randwick plant has been moved to the Military Road, North Sydney, where two motor cars and two trailers are used. The overhead construction is partly suspended from side brackets, and partly by suspension wires, the poles being wooden with a curved iron bracket at the top, the trolley being mounted on a swivel, as in the North Staffordshire plan. A Thomson-Houston generator is used, driven by a Westinghouse engine, which is supplied with steam from the boilers of the cable tram engines; the plant being located in the cable tram engine house. A feature of this line is an accumulator house at the far end of the line, containing 250 Planté cells, to steady the load on the engine and provide power when the engine is shut down. The work has been carried out by the Railway Department, to the design, and under the supervision of, Mr. P. B. Elwell, M.I.E.E., electrical engineer to the Department. The construction work has been carried out under the charge of Mr. G. Findlater Clements, A.I.E.E., of the electrical engineers' branch of the Railway Department.

An important piece of work was inaugurated on Wednesday in the starting of an electrical pumping plant at the Co-operative Colliery, Plattsburg, near Newcastle. Steam has been used hitherto, but the pipes used in conveying the steam from the engine house at the mouth of the tunnel when heated have the effect of softening and disintegrating the roof, and frequent heavy falls of shale, which forms the covering, have resulted, suspending the work of pumping and causing a lot of expense. Mr. Reginald Laidley, the consulting engineer to the colliery, was present at the meetings of the Electric Club at which the reading and discussion of Mr. O. W. Brain's paper on "Electricity as Applied to Mining" took place. The germ was there and then planted, resulting in the order being given to the Crompton Electric Supply Company, of Sydney. The plant consists of a 4½-unit Crompton series-wound dynamo, worked by a 4 H.P. (nominal) Tangye engine located at the pit mouth, and a similar series-wound motor and Tangye pump at the pumping station in the mine, half a mile from the pit mouth. Power is transmitted by two 7/16 Callender cables. The pump at the trial gave a delivery of 4,000 gallons per hour. The work was carried out by Mr. O. W. Brain, of the electrical staff of the Crompton Company. Upon the success of this plant, no doubt, depends the placing of many similar orders.

NEW PATENTS—1893.

21,580. "Improvements in electrical signalling, recording, and detecting apparatus." T. DAVIS and E. DAVIS. Dated November 13th.

21,592. "Improved means of obtaining electrical contacts, disconnections, and reversing currents for operating electrical indicators or signals." H. REID. Dated November 13th. (*Complete.*)

21,609. "A method and apparatus for the production of light by electric and electro-magnetic oscillations and vibrations." A. R. UPWARD. Dated November 13th.

21,619. "An electro deposit of zinc." J. NIXON. Dated November 13th.

21,624. "Improvements in or connected with electrical storage batteries." E. A. MCLACHLAN. Dated November 13th.

21,628. "Improvements in telegraphy." P. B. DELANY. Dated November 13th. (*Complete.*)

21,629. "Improvements in cable and submarine telegraphy." P. B. DELANY. Dated November 13th. (*Complete.*)

21,630. "Improvements in telegraphy." P. B. DELANY. Dated November 13th. (*Complete.*)

21,631. "Improvements in electrolysis and in apparatus therefor." W. H. CALDWELL. Dated November 13th.

21,633. "Improved process for the extraction of gutta-percha from gutta-percha trees, also applicable to the extraction of India-rubber or other like gums from their respective gum trees." A. ARNAUD and A. HOUSEAL. Dated November 13th.

21,637. "An automatic electric signal for tramways and the like." H. O. FISHER and W. W. PHILLIPS. Dated November 13th.

21,707. "Production of ozone and luminosity." E. ANDREOLI. Dated November 14th. (*Complete.*)

21,714. "Improved electric exchange systems with apparatus therefor, applicable also for telegraphic and electric type-writing purposes." S. D. WILLIAMS. Dated November 14th.

21,716. "Improvements in the means of producing electric light." J. CLEGG. Dated November 14th.

21,734. "Improvements in dynamo-electric machines." D. H. WILSON. Dated November 14th. (*Complete.*)

21,812. "Improvements in electrical means of advertising." A. R. UPWARD. Dated November 15th.

21,854. "Improvements in rheostats." C. A. HUSSEY. Dated November 15th.

21,932. "Improvements in electric cigar-lighters and analogous objects." F. W. SCHINDLER. Dated November 16th.

21,933. "Improvements in electrical cooking appliances." F. W. SCHINDLER. Dated November 16th.

21,958. "Improvements in and relating to electric lamps for bicycles and similar vehicles." H. H. LAKE. (Communicated by G. Mayr, United States.) Dated November 16th.

21,966. "An improved electrical drop indicator." E. BEAL. Dated November 17th.

22,027. "Improvements in electric instrument protectors." H. REASON. Dated November 17th.

22,030. "A method of applying electricity to the mechanism of lights for lighthouses, buoys, beacons, and the like." H. M. HUBERT. Dated November 17th.

22,032. "Improvements in accumulator batteries." G. R. BLOT. Dated November 17th.

22,053. "Improvements in or connected with so-called "dry" electrolytes for secondary batteries." V. C. DOUBLEDAY. (Communicated by M. Süssmann, Germany.) Dated November 17th.

22,075. "Improvements in electric furnaces for welding or heating metals." C. F. PARKINSON and THE LANCASTER RAILWAY CARRIAGE AND WAGON COMPANY, LTD. Dated November 18th.

22,080. "Compound-plates for etching purposes, consisting of

zinc electrically plated with copper or the like." H. BERNERT. Dated November 18th.

22,131. "Improvements in switches for controlling electric current circuits in parallel supply systems." W. LOWRIE. Dated November 18th. (*Comp'ete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

7,855. "Electric switches." C. E. CHALLIS. Dated April 26th. The inventor mounts a polygon or other suitably shaped plate upon a base, and on this he places a contact bar, which has a lip turned over one side of the plate and arms which may for flexibility rise vertically to a certain height, and then curve downwards to the contact plates. He also uses a central spindle encircled by a helical spring, the two ends of which press upon the respective arms of the contact bar aforesaid or its equivalent, and a handle carrying a lifting or tripping piece is also loosely mounted upon the spindle, but is prevented from turning beyond a certain arc by a stop formed on a suitably shaped washer, or its equivalent. 1 claim.

8,222. "Improvements in dynamo-electric machines and motors." W. C. RECHNIEWSKI. (Under International Convention.) Dated October 31st, 1891. The object of this invention is to obtain a dynamo-electric machine from which two different voltages can be obtained, for example 100 volts and 200 volts, and so arranged that it can be accomplished by a simple change of connections. 3 claims.

8,745. "Improvements in switches for electric light work." B. M. DRAKE and J. M. GORHAM. Dated May 9th. The object of the invention is to provide a means by which it is rendered impossible for the attendant to pass the current in the reverse direction through the extra cells of the secondary battery. 1 claim.

9,450. "Improvements in electric bells." WOODHOUSE & RAWSON UNITED, LTD. (Communicated from abroad by R. Varley, of New Jersey.) Dated May 18th. Relates more especially to an improved method for locking the adjustable contact screw and protecting the point of "make and break" in an ordinary electric trembling bell. 3 claims.

9,566. "Improvements in electric percussive tools." L. B. ATKINSON. Dated May 19th. The moving part of the tool consists of a central rod on which is mounted a solid cylinder or, equivalently, a number of discs of iron are threaded thereon, as used in the construction of dynamo or motor armatures. This moving part is carried by bearings in which it can freely reciprocate and be rotated if desired, this part is equivalent to the moving field magnet of a motor having a fixed armature. Surrounding this said solid cylinder are arranged one or more laminated magnetic cores on which are wound coils corresponding to the armature coil of a motor. 4 claims.

9,748. "Improvements in or relating to armature and transformer cores and the like." W. L. SPENCE. Dated May 23rd. Relates to an improved method of manufacture and construction of the cores of dynamo armatures, transformers and the like, and it is more particularly applicable to apparatus of the Pacinotti type, *i.e.*, short, flat-ring cores with radial slots in which the wire is wound. 10 claims.

9,799. "Improvements in apparatus and means for the electrolysis of alkaline chlorides." D. G. FITZGERALD. Dated May 24th. Consists, firstly, of an electrolytic tank in which the use of a porous diaphragm separating the anode and the cathode, may be either wholly dispensed with or may be limited to a portion, usually the upper portion, of the electrolytic cell. Secondly, means for obviating the evolution of gases within the electrolytic tank, which latter usually consists of a number of electrolytic cells or anode and cathode alternations. 3 claims.

10,022. "Improvements in electro-telephonic apparatus." C. J. GRIST. Dated May 26th. Consists in making the stand of the telephone which contains the call bell coil somewhat deeper than usual, and above the bell coil is formed a recess in which is placed a microphone, and above the microphone is attached a transmitting diaphragm, the microphone being connected to the battery and line in the usual way. 1 claim.

10,059. "Improvements connected with tubular electric conductors." E. PAYNE. Dated May 27th. Relates to improvements in the system of tubular electric conductors and fittings described in Specification No. 17,402, 1890. 4 claims.

10,161. "Improved means of telegraphic communication with lightships." S. EVERSHED. Dated May 28th. According to this invention telegraphic communication may be carried on between a lightship and the shore by means of the magnetic induction between a telegraph-cable laid on the sea bottom in a ring round the ship and passing thence to the shore and a coil of insulated wire attached to the ship, both the coil and ring of cable having their magnetic axes in a vertical direction. 4 claims.

10,265. "Improvements in electrical measuring instruments." W. E. AYRTON and T. MATHER. Dated May 30th. The improvements consist:—1st, in arranging that the instruments are astatic, and therefore uninfluenced by external fields; 2nd, in placing the coil or coils in such positions relative to the direction of the magnetic field or fields by which the motions are influenced, so as to obtain great sensitiveness about a particular part of the scale; 3rd, in the application of magnetic control to instruments having narrow coils, thereby making their sensitiveness independent of changes in the strength of the magnetic field, and obtaining a control suitable for instruments requiring to be very sensitive at one part of their scales; 4th, in combining a switch with "set up" devices in instruments intended to be very sensitive about a particular part of the scale; 5th, in constructing narrow coil instruments as portable ballistic galvanometers, which are sometimes arranged as direct reading coulombmeters, inductometers, gaussmeters, or magnetic field measurers of long range, or as ammeters or voltmeters; 6th, in arranging the parts of instruments so that very long ranges may be obtained; and 7th, in combining movable coil instruments with recording devices. 7 claims.

10,472. "Improvements in apparatus for electrical and magnetic measurements." J. A. EWING. Dated June 2nd. Consists of a conducting wire or wires tightly stretched between supports in a magnetic field, a magnet or other appliance for producing the field, which is arranged in such a manner that the lines of force of the field lie across the stretched wire, and an indicating apparatus by which any deflection of the central portions of the wire across the lines of force of the field is magnified for observation. 5 claims.

10,608. "Improvements in electrical accumulators." B. M. DRAKE, J. M. GORHAM, W. C. JOHNSON, and S. E. PHILLIPS. Dated June 3rd. The invention relates to an improved method of supporting and carrying accumulator plates of the laminated type, and consists in continuing the solid frames or lugs under the plate on each end. 1 claim.

10,632. "Improvements in electric switches." C. T. B. BRAIN. Dated June 4th. Relates to an improved method of constructing and fixing an electric switch, whereby it is made stronger and simpler, and the number of holes necessary to drill into the base plate less. 3 claims.

10,855. "Improvements in secondary batteries." H. F. KIRKPATRICK-PICARD and H. THAME. Dated June 8th. Is based upon the fact that red lead Pb_3O_4 can be reduced to metallic lead by an admixture of a due proportion of sulphide of lead Pb S with the simultaneous formation of sulphur dioxide. 3 claims.

11,050. "Improvements connected with tubular electric conductors." D. COOK and E. PAYNE. Dated June 13th. Relates to the subdivision and insulation of the conductors. 5 claims.

11,085. "Improvements in electrical indicators." WOODHOUSE AND RAWSON UNITED, LIMITED. (Communicated by R. Varley, of New Jersey.) Dated June 13th. The object of this invention is to effect a cheap, simple and reliable method for automatically calling the attention of persons to matters which require attention at any prearranged time or times. 4 claims.

11,382. "An improved process for manufacturing compound and elementary bodies or chemical products by means of electricity, and apparatus therefor." H. NIEWERTH. Dated June 17th. The inventor manufactures the products by the direct combination of their elements, which are either brought together in one uncombined state or are formed, partially or entirely, in the course of the process. 5 claims.

11,487. "An apparatus for erecting top and middle sections of telephone or other poles." R. F. JEFFRIES. Dated June 20th. The apparatus consists of a pole, 2 clips, and 2 arms. 2 claims.

11,525. "Apparatus for use in manufacturing electric cables." G. G. M. HARDINGHAM. (A communication from the firm of Felten and Guilleaume, of Mullheim.) Dated June 20th. Relates to apparatus for use in manufacturing electric cables the naked conductors of which are, with a view to reducing the "capacity," separated by a strip of insulating material having grooves or channels forming air-spaces for completing the insulation; the objects of the invention being to provide means for folding the strip and for twisting the conductors and the strip together in the same machine. 4 claims.

11,532. "Improvements in secondary or storage batteries." W. A. BOESE. Dated June 20th. Oxide or peroxide of lead, or the lead metal itself, is reduced to a finely disintegrated state, preferably to a fine powder. To the said powder or reduced material, is added a sufficient quantity of a solution in alcohol, or alcoholic substance, of the solid residues, which remain, if coal-tar is subjected to distillation by water. Mixed up with the said solution, the active material forms a strong paste of which the plates are formed by filling the paste into suitable forms. The said forms are then exposed to a moderate heat not exceeding 35° Celsius, for the purpose of evaporating the alcohol. Hardness is obtained by treating the plate with a suitable acid, preferably sulphuric acid in a diluted state. 4 claims.

11,664. "Improvements connected with tubular electric conductors and their insulation." E. PAYNE. Dated June 22nd. Relates to the methods of forming the inner rings or ring separators that are placed along the inner conductor which may be tubular or solid, and to the methods of fixing the ring separators. 5 claims.

11,823. "Improvements in apparatus for measuring electric currents." H. ARON. Dated June 24th. The object of the present invention is, first, to provide an improved construction of the escapement of the clock or clocks, for the purpose of preventing undue influences, such as the influence of terrestrial magnetism exercised on the escapement wheels of the usual construction, and, secondly, to provide a common driving mechanism for the two clock or wheel works of the measuring apparatus. 3 claims.

12,906. "Improvements in and relating to "roses" or electrical connections for the ceilings of buildings or structures." W. M. HADDOW and J. S. HUTCHISON. Dated July 14th. Comprises a new mode of and means or arrangement and combination of the parts of "roses" or electrical connections specially suitable for the ceilings of the rooms of buildings, ships, or other structures, whereby the main or sub-main wires will be tapped by terminal blocks fixed to the base, and the joints or electrical connections heretofore used in these ceiling "roses" dispensed with. 3 claims.